


I-495 Corridor Transportation Study

Developing Transportation Solutions for the I-495 Corridor from Westford to Salisbury


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EOT
Massachusetts Executive Office of Transportation & Public Works

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Table of Contents

Page

Summary xi

1.0 Introduction 1-1

1.1 Development of the I-495 Corridor 1-1

1.2 Study Area 1-3

1.3 Goals and Objectives 1-4

1.4 Study Context 1-4

1.5 Public Involvement 1-7

2.0 Existing Conditions 2-1

2.1 Introduction 2-1

2.2 I-495's Diverse Roles 2-1

2.3 Existing Conditions 2-3

2.3.1 Transportation 2-3
2.3.1.1 I-495 and its Interchanges 2-3
2.3.1.2 Traffic Volumes 2-12
2.3.1.3 Travel Time Runs 2-35
2.3.1.4 Traffic Operations Analysis Criteria 2-35
2.3.1.5 Existing (2006) Peak Hour Traffic Operations 2-39
2.3.1.6 Crashes 2-62
2.3.1.7 Public Transportation 2-64
2.3.1.8 Transportation Management Associations (TMAs) 2-72
2.3.1.9 Park & Ride Lots 2-73
2.3.1.10 Summary Evaluation of Existing Transit Conditions 2-73
2.3.1.11 Regional Transit Travel Times 2-74
2.3.1.12 Trends 2-74
2.3.1.13 Intelligent Transportation Systems (ITS) 2-76
2.3.1.14 I-495 Rest Areas 2-76

2.3.2 Land Use 2-76

2.3.3 Socio-Economics 2-85
2.3.3.1 Population and Households 2-85
2.3.3.2 Employment 2-87

Table of Contents
Continued

Page

2.3.4 Natural Environment 2-88
2.3.4.1 Wetlands, Floodplains and Surface Waterbodies 2-88
2.3.4.2 Public Water Supplies 2-90
2.3.4.3 Rare Species Habitat 2-90
2.3.4.4 Historic Resources 2-90

2.4 Summary of Existing Conditions/Issues 2-91

3.0 Future No-Build Conditions 3-1

3.1 Introduction 3-1

3.2 Future No-Build Conditions 3-1

3.2.1 Transportation 3-1
3.2.1.1 Traffic Volumes 3-1
3.2.1.2 Projected (2030) No-Build Peak Hour Traffic Operations 3-7
3.2.1.3 Crashes 3-40
3.2.1.4 Future Transportation/Transit Improvements 3-40

3.2.2 Land Use 3-47

3.2.3 Socio-Economics 3-49

3.2.4 Summary of Key Future Traffic Issues 3-49

4.0 Recommended Improvements Plan 4-1

4.1 Introduction 4-1

4.2 Non-Highway-Capacity-Enhancing Strategies 4-2

4.2.1 Land Use/Trip Generation 4-3

4.2.2 Public Transportation Improvements 4-6

4.2.3 Park & Ride Lots 4-8

4.2.4 Summary 4-12

4.3 Potential Near-Term Improvements (Less Than 2 Years) 4-12

4.3.1 Western Segment 4-17

Table of Contents Continued

Page

4.3.2 Eastern Segment....4-18

4.4 Potential Mid-Term Improvements (2 to 8 Years)....4-18

4.4.1 Western Segment....4-20

4.4.2 Eastern Segment....4-32

4.5 Potential Long-Term Improvements (More Than 8 Years)....4-41

4.5.1 I-495 Mainline Improved Operations....4-43

4.5.2 I-495 Ramp Intersections with Local Street Improved Operations....4-44

4.5.3 I-495 Merge and Diverge Improved Operations....4-44

4.5.4 I-495 Weave Operations....4-65

4.5.5 Western Segment....4-66

4.5.6 Eastern Segment....4-67

4.6 Crashes....4-72

4.7 Intelligent Transportation System (ITS)....4-74

4.8 Potential New I-495 Interchange at State Route 225 in Westford....4-75

4.9 Summary of Improvement Costs....4-76

4.10 Next Steps....4-77

List of Appendices

Appendix A Public Participation

Appendix B Existing Conditions

Appendix C Levels of Services

Appendix D Levels of Service with Improvements

Compact Disk

Main Report

Appendices A-D

Technical Appendix:

- 2006 Existing Intersection Analysis
- 2006 Existing Traffic Counts
- 2030 No-Build Intersection Analysis
- Crashes
- CTPS Data and Info
- Improvement Costs
- Intersection Analysis with Improvements
- Known Developments
- Link Analysis
- Merge, Diverge, & Weave Analysis
- Truck Percentages

List of Figures

Figure		Page
1-1	Study Area	1-5
2-1	Traffic Volumes and Growth: Annual Average Daily Traffic Volume (1998-2002)	2-13
2-2a	ADTs from 1962-2005 on I-495 in Chelmsford, South of Route 4	2-14
2-2b	ADTs from 1962-2005 on I-495 at Andover/Lawrence Municipal Line	2-16
2-2c	ADTs from 1962-2005 on I-495 at Amesbury/Merrimac Town Line	2-17
2-3	2004 Average Weekday Daily Traffic and 2006 AM and PM Peak Directional Volumes Western Segment	2-19
2-4	2004 Average Weekday Daily Traffic and 2006 AM and PM Peak Directional Volumes Eastern Segment	2-21
2-5	2006 AM Peak Hour Volumes Western Segment	2-23
2-6	2006 AM Peak Hour Volumes Eastern Segment	2-25
2-7	2006 PM Peak Hour Volumes Western Segment	2-27
2-8	2006 PM Peak Hour Volumes Eastern Segment	2-29
2-9	CTPS Travel Time Runs (1999-2000)	2-36
2-10	Example of Weave, Merge and Diverge Operations	2-40
2-11	2006 AM Peak Hour LOS Intersection Operations Western Segment	2-43
2-12	2006 AM Peak Hour LOS Intersection Operations Eastern Segment	2-45
2-13	2006 PM Peak Hour LOS Intersection Operations Western Segment	2-47
2-14	2006 PM Peak Hour LOS Intersection Operations Eastern Segment	2-49
2-15	2006 AM Peak Hour Ramp Operations Western Segment	2-53
2-16	2006 AM Peak Hour Ramp Operations Eastern Segment	2-55
2-17	2006 PM Peak Hour Ramp Operations Western Segment	2-57
2-18	2006 PM Peak Hour Ramp Operations Eastern Segment	2-59
2-19	Annual Crash Statistics by Interchange (2002-2005)	2-63
2-20	Bus Routes I-495 Corridor Transportation Study Area	2-65
3-1	2030 Average Weekday Daily Traffic and AM and PM Peak Directional Volumes Western Segment	3-3
3-2	2030 Average Weekday Daily Traffic and AM and PM Peak Directional Volumes Eastern Segment	3-5

List of Figures Continued

Figure		Page
3-3	2030 AM Peak Hour Turning Movement Volumes Western Segment	3-9
3-4	2030 AM Peak Hour Turning Movement Volumes Eastern Segment	3-11
3-5	2030 PM Peak Hour Turning Movement Volumes Western Segment	3-13
3-6	2030 PM Peak Hour Turning Movement Volumes Eastern Segment	3-15
3-7	2030 AM Peak Hour LOS Intersection Operations Western Segment	3-17
3-8	2030 AM Peak Hour LOS Intersection Operations Eastern Segment	3-19
3-9	2030 PM Peak Hour LOS Intersection Operations Western Segment	3-23
3-10	2030 PM Peak Hour LOS Intersection Operations Eastern Segment	3-25
3-11	2030 AM Peak Hour Ramp Operations Western Segment	3-27
3-12	2030 AM Peak Hour Ramp Operations Eastern Segment	3-29
3-13	2030 PM Peak Hour Ramp Operations Western Segment	3-33
3-14	2030 PM Peak Hour Ramp Operations Eastern Segment	3-35
3-15	2030 AM Peak Hour Link Operations Western Segment	3-37
3-16	2030 AM Peak Hour Link Operations Eastern Segment	3-41
3-17	2030 PM Peak Hour Link Operations Western Segment	3-43
3-18	2030 PM Peak Hour Link Operations Eastern Segment	3-45
4-1a	Total Trips Generated by Corridor Communities	4-5
4-1b	Total Trips on I-495 in the Study Area – 2006 Three-Hour AM Peak Period	4-5
4-1c	Total Trips Generated by Corridor Communities 2006 AM Three Hour Peak Period	4-5
4-2a	Potential Park and Ride Lot at Tewksbury, Exit 39 at Route 133	4-10
4-2b	Potential Park and Ride Lot at Haverhill, Exit 50 at Route 97 in Church Parking Lot	4-10
4-3	Potential Park and Ride Lot in Haverhill at Exit 52 and Route 110	4-11
4-4	Potential Intersection Improvements in Western Segment	4-13
4-5	Potential Intersection Improvements in Eastern Segment	4-15
4-6	Acceleration and Deceleration Lane Improvements in Western Segment	4-21
4-7	Acceleration and Deceleration Lane Improvements in Eastern Segment	4-23

List of Figures Continued

Figure **Page**

4-8 Existing Condition and Proposed Improvement at Exit 33 NB and Route 4 in Chelmsford 4-25

4-9 Existing Condition and Proposed Improvement at Exit 34 NB and Route 110 in Chelmsford 4-27

4-10 Existing Condition and Proposed Improvement at Exit 34 SB and Route 110 in Chelmsford 4-28

4-11 Existing Condition and Proposed Improvement at Exit 37 NB and Woburn Street in Lowell 4-30

4-12 Existing Condition and Proposed Improvement at Exit 37 SB and Woburn Street in Lowell 4-31

4-13 Existing Condition and Proposed Improvement at Exit 43 NB and Mass Ave in Lawrence 4-34

4-14 Existing Condition and Proposed Improvement at Exit 43 SB and Loring Street in Lawrence 4-36

4-15a Limits of Proposed Improvement on Route 125 NB (Exit 51) in Haverhill 4-39

4-15b Existing Conditions on Route 125 NB (Exit 51) in Haverhill 4-39

4-16a Existing Conditions (continued) on Route 125 NB (Exit 51) in Haverhill 4-40

4-16b Existing Roadway Cross-Section on Route 125 NB (Exit 51) in Haverhill 4-40

4-16c Proposed Roadway Cross-Section on Route 125 NB (Exit 51) in Haverhill 4-40

4-17 Existing Condition and Proposed Improvement at Exit 55 NB and Route 110 in Amesbury 4-42

4-18 Limits of Western Segment Add-a-Lane Improvement 4-45

4-19 Limits of Eastern Segment Add-a-Lane Improvement 4-47

4-20 2030 AM Build with Improvements Peak Hour LOS Intersection Operations Western Segment 4-49

4-21 2030 Build with Improvements AM Peak Hour LOS Intersection Operations Eastern Segment 4-51

4-22 2030 PM Build with Improvements Peak Hour LOS Intersection Operations Western Segment 4-53

4-23 2030 Build with Improvements PM Peak Hour LOS Intersection Operations Eastern Segment 4-55

List of Figures
Continued

Figure **Page**

4-24 2030 Build with Improvements AM Peak Hour Ramp Operations Western Segment 4-57

4-25 2030 Build with Improvements AM Peak Hour Ramp Operations Eastern Segment 4-59

4-26 2030 Build with Improvements PM Peak Hour Ramp Operation Western Segment 4-61

4-27 2030 Build with Improvements PM Peak Hour Ramp Operations Eastern Segment 4-63

4-28 Existing Condition and Proposed Improvement at Exit 32 NB and Boston Road in Westford 4-68

4-29 Existing Condition and Proposed Improvement at Exit 49 NB and SB and Route 110/113 in Haverhill 4-69

4-30 Existing Condition and Proposed Improvement at Exit 52 NB and Route 110 in Haverhill 4-73

List of Tables

Table		Page
1-1	Public Involvement	1-9
2-1	Percentages of Trucks in I-495 Study Area	2-33
2-2	Peak Period Truck Percentages at Selected Locations on Major State Highways	2-34
2-3	Intersection Level of Service Criteria	2-38
2-4	I-495 AM and PM Peak Hour Level of Service for Selected Link Analysis	2-61
2-5	Ranking of Corridor Interchanges by Crash Number and Types 2002-2005	2-62
2-6	LRTA Bus Routes and Operational Characteristics	2-66
2-7	Top 2004-5 LRTA Bus Routes Based on Daily Ridership	2-67
2-8	MVRTA Routes and Service Characteristics	2-69
2-9	Top MVRA Routes in 2002	2-70
2-10	Park & Ride Lots in the Study Area	2-73
2-11	Regional Transit Travel Times	2-74
2-12	Land Use	2-79
2-13	Potential Additional Development within the I-495 Corridor Communities	2-81
2-14	Existing and Projected Population	2-86
2-15	Existing and Projected Households	2-87
2-16	Existing and Projected Employment	2-88
4-1	Preliminary Estimate of Construction Costs	4-76

Summary

I. Introduction

The Interstate 495 Corridor Transportation Study examined existing and future transportation conditions on a 40-mile section of I-495 between Westford and Salisbury, Massachusetts. Within this distance, I-495 traverses 13 communities and 2 regional planning boundaries-the Northern Middlesex Council of Governments (NMCOG) in the corridor's Western Segment and the Merrimack Valley Planning Commission (MVPC) in the Eastern Segment. Between the study area's western and eastern termini, I-495 includes 25 interchanges, 3 of which are interchanges with limited-access highways. This summary outlines the study framework, findings, and recommendations for improvements. For more detailed information, please refer to the remainder of the report and the appendices.

Based on analyses of 2006 and 2030 operating conditions as well as the public participation process, the study evaluates a range of potential solutions to identified problems. The possible solutions include expanded transit, managing trip generation from future development, carpooling from Park & Ride lots, Transportation System Management (TSM) actions, and, finally, roadway capacity increases.

II. Study Goals and Objectives/Public Involvement

As developed in coordination with the Study Advisory Group (SAG), which consisted of representatives from corridor communities, state and regional agencies, and legislators, the goal for this study was to provide improved safety and mobility on the I-495 mainline and at its interchanges. This goal focused study efforts on those points where drivers enter or exit the Interstate at the junction of its ramps with local streets and on operations of its travel lanes proper.

During the course of this study, several meetings were held with the SAG and a newsletter was prepared. A project-specific web site was established for use by interested parties in reviewing study progress and through which they could offer their comments. Meetings were also held with the two regional planning agencies to discuss identified issues. Near the conclusion of the study, two public informational meetings were held to present study findings, conclusions, and a program of potential improvements.

III. Existing 2006 Conditions

Existing conditions along the I-495 study corridor have been documented with regard to transportation, land use, socio-economic characteristics, and the environment.

The study has examined existing daily and peak hour traffic volumes on I-495, level of service (LOS), a four-year vehicle crash history at the highway's interchanges, operational characteristics of existing public transportation services in the area, and the location of Park & Ride lots.

Existing traffic volumes vary widely along the corridor. For example, at the far western end of the study corridor in Westford, average weekday daily traffic (AWDT) is 123,500 vehicles, while at the far eastern end of the corridor in Salisbury AWDT is only 45,000 vehicles. Similar variations were determined to occur during the AM and PM peak hours.

A key emphasis of the examination of existing conditions was the determination of how well I-495 and its interchanges are currently operating. Using the concept of LOS, which is a measure of the efficiency of traffic operations, analyses were undertaken from three perspectives: (1) signalized and unsignalized intersections at locations where ramps to and from I-495 meet the local street system, (2) merge, diverge, and weave movements at points along I-495 such as on-ramps and off-ramps, and (3) key links on I-495 between interchanges. In all cases, analyses were performed for both the AM and PM weekday peak hours.

In the Western Segment (Exits 32-40) of the I-495 study corridor, there are 6 signalized intersections, all of which were determined to be operating at overall levels of service (LOS A-D) during both the AM and PM peak hours, although a small number of individual movements (2 out of a total of 44, or 5 percent) within these intersections do experience congestion (LOS E or LOS F) during the AM peak hour. During the PM peak hour, 3 movements out of a total of 44, or 7 percent, experience congested operations.

For the 15 unsignalized intersections in the Western Segment, LOS is determined only for individual conflicting movements within the intersections and not for the intersections as a whole. Analysis results showed that 20 (87 percent) of the 23 such movements operate without congestion during the AM peak hour, while 18 (78 percent) do so during the PM peak hour.

With regard to the Eastern Segment (Exits 41-55) of the corridor, all five signalized intersections currently operate at overall acceptable LOS during both the AM and PM peak hours. No individual movements at signalized

intersections were determined to be operating unacceptably during the AM peak hour, with only 1 movement (3 percent out of a total of 34 movements) having congestion during the PM peak hour.

The 15 unsignalized intersections in the Eastern Segment contain a total of 63 movements that were analyzed. During the AM peak hour, 59 movements (94 percent) operate at LOS D or better, while during the PM peak hour 54 movements (86 percent) operate at LOS D or better.

In summary, all signalized intersections currently operate at LOS D or better overall during both the AM and PM peak hours. Only a small number of individual traffic movements within these intersections currently experience congested operations. For unsignalized intersections, the vast majority of individual traffic movements within these intersections currently operate at LOS D or better during both the AM and PM peak hours.

In the Western Segment, the analysis of merges, diverges, and weaves determined that 34 locations (89 percent) out of a total of 38 that were examined currently operate at LOS D or better during the AM peak hour. During the PM peak hour, 32 locations (84 percent) currently operate uncongested at LOS D or better. In the Eastern Segment, a total of 65 merge, diverge, and weave locations was examined. For the AM peak hour, it was determined that 61 locations (94 percent) operate at LOS D or better. The corresponding figures for the PM peak hour in the Eastern Segment are 63 locations (97 percent) at LOS D or better.

Also identified were deficiencies in the length of 24 acceleration lanes or deceleration lanes serving I-495’s on- and off-ramps, respectively.

Key links between interchanges along the length of the I-495 study corridor were examined for their existing LOS. All were found to be operating at LOS D or better.

Data on crashes was compiled for a four-year period from 2002 to 2005. Interchanges were subsequently ranked according to total number of crashes, crashes involving property damage, crashes involving personal injuries, and crashes involving fatalities.

Public transportation in the study area consists largely of systems concentrated in the Lowell and Lawrence areas and of commuter rail service to and from Boston. Several transportation management agencies specializing in carpooling also operate in the area.

IV. Projected 2030 Conditions

Traffic volumes along I-495 are expected to grow into the future, but at a slower rate than they have been growing in the past. On the western end of the study corridor, AWDT on I-495 in Westford will grow from its existing volume of 123,500 vehicles in 2006 to 146,400 in 2030. At the eastern end of the study corridor in Salisbury, AWDT will grow from 45,000 vehicles in 2006 to 62,000 in 2030.

The projected increases in traffic volumes by 2030 will be accompanied by increases in traffic congestion, both on the I-495 mainline and at many of its 25 interchanges within the study corridor.

The effects of increased traffic volumes will be more profound with respect to some aspects of the roadway system than with others. For example, all six currently signalized intersections in the Western Segment of the study corridor will continue to operate at LOS D or better in 2030 during both the AM and PM peak hours, as they did in 2006. During the AM peak hour at these same intersections, the number of individual movements operating at LOS D or better will decrease from 42 out of 44 movements (95 percent) in 2006 to 40 movements (91 percent) by 2030, a relatively small change.

Seven signalized intersections in the study corridor's Eastern Segment will operate at LOS D or better during the AM peak hour, but only six (86 percent) of the seven will do so during the PM peak hour.

Further, it was determined that all (100 percent) highway links currently are operating at LOS D or better in 2006 during both the AM and PM peak hours. However, this is not projected to be the case in 2030. By that time, in the Western Segment of the study corridor during the AM peak hour, only 39 percent of the links will be operating at LOS D or better. During the PM peak hour, 56 percent of these same links will operate at LOD D or better. In the Eastern Segment, 22 links (74 percent) of 30 will operate at LOS D or better during the AM peak hour, while 23 links (77 percent) will do so during the PM peak hour. More details of future traffic conditions can be found in Chapter 3 and the appendices.

V. Alternatives Analysis

Various highway and non-highway alternatives were evaluated for their effectiveness in addressing capacity deficiencies. These types of alternatives included additional transit services, promotion of land uses that have lower trip generation rates, provision of more Park & Ride lots, intersection improvements, and merge and diverge improvements.

VI. Improved 2030 Operating Conditions

The recommended program of improvements, summarized below, addresses identified problems at signalized and unsignalized intersections; merge, diverge, and weave locations; and the I-495 mainline links and interchanges themselves. With the exception of several locations involving weaves, the program, if implemented, would restore all operations to LOS D or better. Several weave locations at interchanges where congested levels of service are projected to exist would require the involved interchange to be totally redesigned or relocated in order for the weaving problems to be solved. While these locations are identified, solutions for these particular problems are beyond the scope of this corridor study.

VII. Recommended Improvements Plan

Based on the results of the analyses of existing (2006) and future (2030) operating conditions as well as the public participation process, a set of recommended improvements was developed, and is shown in more detail in Chapter 4. These improvements were grouped according to the time periods during which they would be implemented.

Near-term improvements are those requiring less than two years to implement and are all responses to existing problems. For this program, all recommended near-term improvements involve the retiming of certain traffic signal systems. Specifically, two signal systems are recommended to be retimed in the corridor's Western Segment and one in the Eastern Segment. No environmental impacts from these actions are anticipated.

Mid-term improvements require from two to eight years for implementation, and are intended to solve existing problems. Included is the installation of traffic signal systems at five new locations in the Western Segment and at two new locations in the Eastern Segment. Also included is the lengthening, by means of pavement re-striping, of 8 existing acceleration or deceleration lanes in the Western Segment along with 16 acceleration or deceleration lanes in the Eastern Segment. This lengthening would bring these lanes up to standard and would also improve safety.

Other recommended actions for the mid term would consist of the reconfiguration of the cross-section of a one-mile section of State Route 125 to the north of Exit 50 in Haverhill and the study of the feasibility of constructing new direct connections in Salisbury between I-495 NB and I-95 SB and between I-95 NB and I-495 SB. With the potential exceptions of traffic signal installation work at two locations and the reconfiguration of State Route 125, all mid-term projects are expected

to have little or no environmental impacts. The projects listed as exceptions may involve work in the buffer zones of protected resources and may require coordination with the conservation commissions of the affected communities.

Long-term improvements are those recommended for implementation eight years or more into the future. They are responses to future identified problems. A key recommendation is the widening of I-495 by one travel lane in each direction between Exit 32 and Exit 40 in the Western Segment, exclusive of that portion of the highway between Exits 35 and 36, and the widening of I-495 by one travel lane in each direction to beyond Exit 49, with the exception of the highway segment from just before Exit 43 to just beyond Exit 45. In addition to increasing I-495's mainline capacity, this widening will also improve conditions at many of the previously identified merge and diverge locations with poor LOS. The proposed widening of the I-495 mainline would very likely have substantial environmental impacts.

Also part of the recommended long-term improvement program are the retiming of two existing traffic signal systems (one in the Western Segment and one in the Eastern Segment) and the installation of traffic signal systems at three new locations (all in the Eatern Segment). With regard to deficient weave operations that were identified, several interchanges would require further study for their complete redesign. Also, intersection capacity improvements at one interchange and traffic signal installation at another may involve work within the buffer of a protected resource which would require coordination with the conservation commissions of the communities where those projects are located.

While the above recommendations relate to increasing the roadway system's capacity to accommodate the traffic demands on I-495, other actions aimed at reducing the demand itself (public transportation improvements, additional Park & Ride lots, land use changes) will not by themselves be able to negate the need for roadway capacity improvements. However, these actions should be encouraged wherever possible as components of a total package of strategies to manage traffic throughout the corridor, both now and in the future.

Cost estimates for the recommended improvements plan have been developed in present day (2008) dollars. Summed over the near term, mid term, and long term, they are approximately $102 million for the Western Segment of the study corridor and approximately $77 million for the Eastern Segment, giving a grand total of approximately $179 million.

The next steps for advancing these recommendations involve project initiation and development through coordination with MassHighway, with future steps involving programming of the mid-term projects in the Transportation Improvement Programs (TIP) of the two regional planning agencies. The long-term improvements would also need to be incorporated in the regional long-range transportation plans.

1.0 Introduction

The Massachusetts Executive Office of Transportation and Public Works (EOTPW), in consultation with the Merrimack Valley Metropolitan Planning Organization and the Northern Middlesex Metropolitan Planning Organization, recognized the need to evaluate and address transportation issues in the 40-mile-long section of Interstate 495 (I-495) between Westford and Salisbury. This study, officially called the ***Interstate 495 Corridor Transportation Study***, was initiated by EOTPW to provide a forum for state and regional agencies, municipal officials, business leaders, legislators, transportation service providers, and the general public to collaboratively develop reasonable solutions to identified existing and expected future transportation problems in the study area.

Over time, the role I-495 played in connecting corridor communities to a wider transportation system contributed to their growth and, in part, economic well being. However, following years of expansion in population and employment, the continuing travel demands now placed on I-495 by corridor communities, combined with demands for travel from outside this corridor, are stressing the capacity of I-495.

The concept of this study is to understand the quality of travel afforded by I-495 today and how that quality of travel is likely to change by 2030. The study evaluates how travel limitations that exist now, and may exist in the future, can be resolved over time in a manner that reflects the level of complexity and cost for the needed improvements. Additionally, the roles of transit and, in a general sense, land use are also included in the evaluation of how to attain and maintain an acceptable quality of travel on I-495.

1.1 Development of the I-495 Corridor

The concept of an outer loop highway for eastern Massachusetts was first announced by the Massachusetts Department of Public Works (MDPW), MassHighway's predecessor, in the late 1940s. This proposed outer loop was to be located at an approximate 30-mile radius from Boston and would supplement the "Relocated Route 128", which was to be built to serve the towns in an inner ring at an approximate 15-mile radius from Boston. As conceived, the outer loop highway would be approximately 87 miles in length between Route 1 in Salisbury and Route 1 in Foxborough. Its purpose would be to provide an economic boost to the communities that it would serve by offering greatly improved access to all

parts of the state and nation. This outer loop was initially referred to as "Relocated Route 110" but was ultimately redesignated as I-495. Construction occurred in stages, with the first section completed between Exit 29 (Route 2) in Littleton and Exit 32 (Route 225) in Westford in 1961. The remaining sections of roadway in the Merrimack Valley followed in subsequent years. Specifically, the section of roadway between Exit 32 in Westford and Exit 36 (Route 3) in Chelmsford was completed in 1962, while the section between Exit 36 in Chelmsford and Exit 42 (Route 114) in North Andover was opened to traffic in 1963. Next to come on line, in 1964, was the roadway section between Exit 42 in North Andover and Exit 53 (Broad Street) in Merrimac. The final section in the valley, between Exit 53 in Merrimac and I-95 in Salisbury, opened in 1967.

Numerous technology firms have established business locations along the I-495 corridor, mirroring the Route 128 experience. Traffic volumes in some sections of the corridor are now triple what they were in 1977.

As presented in Figure 1-1, this project's study area extended from Westford east to Salisbury, a distance of approximately 40 miles. Concerns about transportation issues in this corridor resulted in state, regional, and local interest in exploring potential alternative solutions for alleviating existing and expected future traffic congestion, improving regional mobility, and improving safety.

The study involved the development and evaluation of a full range of transportation improvement alternatives, including interchange, highway, and non-highway improvements, as well as multimodal options. A recommended plan of future transportation improvements for the near term (up to 2 years), mid term (2 to 8 years) and long term (more than 8 years) was a key study product.

This report is also a major product of the study. It documents all phases of the work efforts completed, including input from the *Working Group*, the *Study Advisory Group (SAG)*, and the general public. The following chapters comprise this report:

- Chapter 1 – Introduction
- Chapter 2 – Existing Conditions
- Chapter 3 – Future No-Build Conditions
- Chapter 4 – Recommended Improvements Plan

1.2 Study Area

The study area for this project was finalized during the initial stages, with input from the *Working Group* and the *SAG*. The area of the study, depicted in Figure 1-1, extended along the I-495 corridor from Westford in the west to Salisbury in the east. Growth in the study area and growing traffic congestion on I-495 and its interchanges prompted the need to study transportation improvements that would better serve existing and expected future corridor transportation needs.

The study area included the following I-495 interchanges:

<u>Western Segment</u>

- Exit 32: Boston Road in Westford
- Exit 33: State Route 4 (North Road) in Chelmsford
- Exit 34: State Route 110 (Chelmsford Street) in Chelmsford
- Exit 35: U.S. Route 3 at the Lowell city line in Chelmsford
- Exit 36: Lowell Connector in Lowell
- Exit 37: Woburn Street in Lowell
- Exit 38: State Route 38 (Main Street) in Tewksbury
- Exit 39: State Route 133 (Andover Street/Lowell Street) at the Tewksbury/Andover municipal line
- Exit 40: I-93 in Andover

<u>Eastern Segment</u>

- Exit 41: State Route 28 (North Main Street and Union Street) in Andover
- Exit 42: State Route 114 (Winthrop Avenue) in Lawrence
- Exit 43: Massachusetts Avenue/Loring Street at the North Andover/Lawrence municipal line
- Exit 44: Merrimack Street/Sutton Street at Lawrence/North Andover municipal line
- Exit 45: Marston Street in Lawrence
- Exit 46: State Route 110 (Merrimack Street) in Methuen
- Exit 47: State Route 213 (Albert Slack Highway) in Methuen
- Exit 48: State Route 125 in Haverhill
- Exit 49: State Routes 110/113 (River Street) in Haverhill
- Exit 50: State Route 97 (Broadway) in Haverhill
- Exit 51: State Route 125 (Main Street) in Haverhill
- Exit 52: State Route 110 (Amesbury Road) in Haverhill
- Exit 53: Broad Street in Merrimac
- Exit 54: State Route 150 in Amesbury
- Exit 55: State Route 110 (Macy Street) in Amesbury
- Junction of I-495 with I-95

1.3 Goals and Objectives

Goals and objectives identify the purpose of the study and provide a "mission statement" for addressing a particular issue or set of issues. The defined goals and objectives shape the framework of the entire study. As established by the *Working Group*, this study's key objective was:

- ***To achieve improved mobility and safety on I-495 and at its interchanges.***

This goal was endorsed by the Study Advisory Group (SAG) at its initial meeting in 2006.

By focusing study efforts on the I-495 mainline and its interchanges, a conscious decision was made to maximize the understanding of how I-495 operates as a corridor and as a series of locations where corridor residents transition between the local street system and the Interstate.

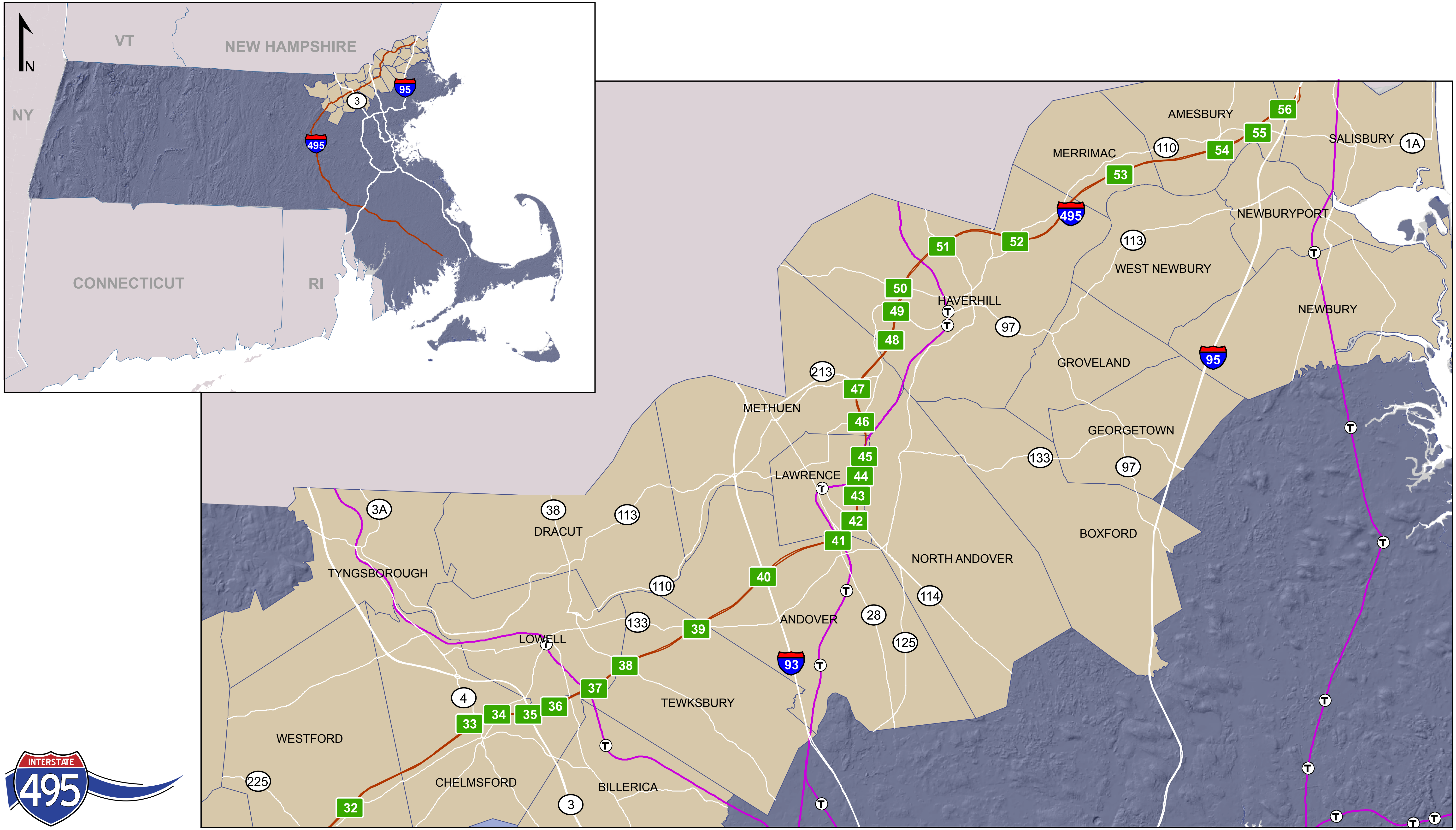
1.4 Study Context

It is recognized that as a corridor planning study, this report is an initial step toward the ultimate improvement of the transportation problems identified in the following chapters. As a first step, this study is intended to collect and explain a large amount of location-specific data, understand how locations operate individually and, where appropriate, to collectively define the user experience of traveling throughout this 40-mile-long corridor.

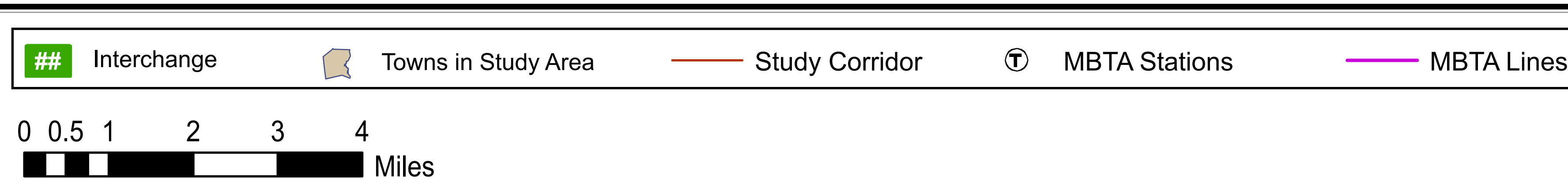
Consequently, this study's intent is to describe existing and expected future operating conditions along 80 miles (40 miles in each direction) of limited access highway, including the operational and crash characteristics of 25 interchanges involving approximately 50 intersections of local streets with Interstate ramps.

Then, based on analysis, the study identifies which of these locations exhibit operational or crash problems today or in 2030. With that knowledge, a range of improvement options for today and the future is evaluated. Finally, this study recommends potential improvements for appropriate locations.

In this way, the study separates I-495's roadway segments, interchanges, and intersections into two basic groups--those that have problems and those that do not. Consequently, this identification of problem and, equally important, non-problem locations is a major product of this corridor study.



Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



I-495 Corridor Study
Figure 1-1
Study Area

Without understanding where the problems exist, little progress can be made toward their resolution.

While potential solutions are identified for problem locations, it is imperative to understand that this is the first step toward the eventual resolution of these identified problems. Later steps will introduce these potential improvements into the public transportation improvements review, approval, and funding process. It is within those later stages that advanced engineering design will occur that will ultimately result in plans upon which improvements will be constructed.

1.5 Public Involvement

A key component of this study was the public involvement process. One of the first tasks of the work effort was to develop a Public Involvement Plan, the details of which can be found in Appendix A of this document along with meeting notes from all public meetings.

The intent of the Public Involvement Plan was to establish a structure and forum for interested and affected parties to provide input and comment on the study process, to provide education and awareness about the project, and to engage key stakeholders in the process as well as to build agreement and support for implementation. Principles to which the public involvement process adhered were also developed at the same time. Included were commitments to create an environment in which decisions were based on an objective, transparent, and inclusive planning process; to ensure open, honest, and clear communications; and to facilitate two-way communications.

The Public Involvement Plan called for the creation of both a *Working Group* and a *SAG* to participate with the EOTPW and the Consultant Team in the process. The roles of each of these Study Participants were specifically defined by the Public Involvement Plan to provide guidance to the involved parties.

The Consultant Team's roles in the public participation process were to perform technical work, to prepare material and presentations for *SAG* meetings, and to prepare material and presentations for public informational meetings.

The roles of the EOTPW, as the study's proponent, were to review the work of the Consultant Team, manage the project, review recommendations, and make final decisions.

The *Working Group* consisted of the EOTPW, the Northern Middlesex Council of Governments (NMCOG); the Merrimack Valley Planning Commission (MVPC); and Fay, Spofford & Thorndike. The latter organization was the prime member of the Consultant Team while NMCOG and MVPC are the two regional planning agencies serving the communities along the I-495 corridor. Roles of the *Working Group* included providing input to the study process, reviewing and revising technical work, and providing input on the recommendations to the EOTPW.

By far the largest group participating in the public involvement process was the *SAG*. Its membership comprised two members of Congress whose districts include the study area, State Representatives and State Senators from the study area, several chambers of commerce representing the business community, representatives from all of the cities and towns in the study area, and representatives from several providers of public transportation in the area. The purpose of the *SAG* was to provide input to the study process, assist with alternatives development, and provide input on the technical materials and alternatives. A complete listing of *SAG* members can be found in Appendix A of this document.

Specific types of public participation activities that occurred throughout this study included stakeholder interviews, *SAG* meetings, regional planning agency briefings, public informational meetings, communication with *SAG* members, and distribution of study information and materials.

Other means that were used to keep the public informed about the study included media releases at key points; the preparation of fact sheets for inclusion in newsletters, etc.; the preparation of articles about the project; and the establishment for use by the public of a project-specific web site (www.495studyinfo.com).

While the I-495 Corridor Study was underway, the public had the opportunity to post any comments that they might have on the study website. A total of 27 comments was posted, and are available for viewing in Appendix A. They ranged from requests for improvements/changes at specific interchanges to comments about the highway's speed limit.

Some of the suggestions for improvements made by the public in their comments are included in the potential improvements specifically discussed in Chapter 4. Examples include traffic signal installations at Exits 33 and 37 and the need to increase mainline capacity in the future by adding travel lanes. This study also recommends that the potential for a full interchange between I-495 and I-95 be examined. Comments regarding issues at the I-495/I-93 interchange have been noted, with

further study being recommended. Other suggestions were out of the scope of this study, such as a request for pothole repairs.

In any case, all of the comments posted by the public on the website were considered when developing the recommended improvements plan presented in Chapter 4.

Table 1-1 lists the *Working Group*, *SAG*, agency, and public informational meetings that were held over the course of the ***Interstate 495 Corridor Transportation Study.*** Notes from these meetings can be found in Appendix A of this document.

Table 1-1
Public Involvement

Group	Date	Location	Agenda
Working Group	April 21, 2005	State Transportation Building	Traffic count program, study-area boundaries, SAG membership, goals and objectives
Study Advisory Group	July 28, 2005	Methuen	Introduction to the study; scope, goals and objectives; evaluation criteria.
Study Advisory Group	Nov. 28, 2006	Tewksbury	Overview of existing conditions.
Working Group	Dec, 20, 2006	NMCOG	Traffic Counts
Working Group	June 14, 2007	State Transportation Building	Model results, seasonality, trucks
Study Advisory Group	Feb. 7, 2008	Haverhill	Review of existing conditions; 2030 projections for traffic; and improvement ideas for the Corridor.
Northern Middlesex COG Councilors	Mar. 19, 2008	Lowell	Overview of key findings; review of proposed Westford interchange at Rte. 225
Merrimack Valley Planning Commission	April 17, 2008	Haverhill	Overview of key findings
Study Advisory Group	April 23, 2008	Tewksbury	Review of proposed non-highways improvements and refined highway improvements.
Western Segment Public Informational Meeting	May 22, 2008	Lowell	Open-house-style meeting and detailed presentation to review the study, problems, and recommended improvements.
Eastern Segment Public Informational Meeting	May 27, 2008	Haverhill	Open-house-style meeting and detailed presentation to review the study, problems, and recommended improvements.

2.0 Existing Conditions

2.1 Introduction

The purposes of this study are (1) to identify transportation problems along the study corridor and (2) to propose improvement projects and/or remediation strategies for those identified problems. Identified issues may be currently existing or projected for the year 2030, this study's future year. This chapter will provide an understanding of how I-495 operates now and will identify the natural resources and socio-economic environments surrounding the roadway, ultimately enabling the reader to develop an understanding of the corridor's environs and how transportation within the I-495 corridor and at its 25 interchanges operates.

A description in this chapter of the physical and traffic operational characteristics of I-495's interchanges is followed by a discussion on the crash history at these same locations. Additionally, this chapter looks at existing public transportation services in the area and their ridership, as well as the area's Intelligent Transportation Systems capabilities.

As there is a direct relationship between land use and transportation demands, this chapter then outlines the existing land use characteristics along the I-495 corridor, focusing on a one-mile radius at each of the corridor's interchanges. Additionally, an examination of socio-economic conditions along the corridor and a summary of the natural resources located adjacent to I-495 are discussed.

2.2 I-495's Diverse Roles

Travel demand on the I-495 corridor is strong, which is due to the fact that the Interstate fulfills a variety of critical functions. As discussed in this chapter's section on land use and socioeconomic characteristics, I-495 is a major factor in influencing development within the multiple communities it passes through. Two distinct patterns of development in these communities prevail: the dense urban development of the mill cities seen in communities such as Lowell and Lawrence, and the evolving patterns of low-density development seen in towns such as Westford and portions of Tewksbury. In the case of older mill cities such as Lowell and Lawrence, their highest populations and development occurred prior to I-495's construction and, thus, I-495 was not a catalyst for their initial growth. However, communities such as Westford and Tewksbury lacked the mature characteristics of older neighboring cities. The availability of undeveloped land, combined with the new accessibility and increased mobility created

by I-495, allowed for the expansion of low-density development patterns that could then be connected to higher-density employment sites. Throughout the Merrimack Valley, travel between these often-distant employment centers and mainly residential communities (or “bedroom communities”) primarily takes place on limited access highways, which has placed a strong demand on the study corridor’s transportation network.

I-495’s multifunctional role as a regional and local roadway can be illustrated by noting results from analyses that the Central Transportation Planning Staff (CTPS) performed using the latest computer modeling techniques. Currently, during the three-hour AM peak period, through trips that do not have either an origin or a destination in any one of the 13 communities along this section of I-495 make up approximately 51 percent of the traffic on the highway. Conversely, the remaining 49 percent of trips on the highway during that time have an origin and/or a destination in those same communities.

Just as I-495 has influenced development patterns, the impacts exerted by development have affected I-495’s operations. As evidenced by the traffic operations analyses presented in this chapter, these impacts vary greatly along the corridor from municipality to municipality. It is at the interchanges that impacts from local streets are transmitted to the I-495 mainline, affecting its primary role of facilitating regional and through travel.

I-495’s function as a major transportation network link is another reason for its high travel demand. I-495 fulfills a critical role in mobility as an inter-regional and interstate travel link, connecting New Hampshire, Maine, and the maritime provinces of Canada with New York and Connecticut, as well as providing connections to I-95, I-93, I-90, U.S. Route 3, and State Route 2. I-495 thus provides a vital function in the movement of people and goods. I-495’s connectivity makes it a choice route in particular for moving goods, while also avoiding the expense of time and fuel lost to congestion and distance when traveling through metropolitan Boston. As illustrated later in this chapter by the high level of trucks mixed into the total volume of traffic on I-495, this feature tends to direct longer distance trips in general, and goods movement in particular, toward this 40-mile section of I-495. Such an effect is perhaps not experienced to this degree beyond the study corridor’s boundaries.

As changes to land use, economics and other factors influence travel demands and patterns, the role and function of I-495 also changes. I-495 is a benign neighbor until it loses its utility. When that happens, either through failure of the highway or failure of the local system, I-495’s ability to meet its designated functions without impacting local travel is reduced.

2.3 Existing Conditions

2.3.1 Transportation

This section first discusses the physical characteristics of both I-495 and its 25 interchanges in the study area, followed by a discussion of the existing volumes of traffic that traverse I-495 within the study area, and the traffic volumes entering and exiting I-495 at each of the 25 interchanges. The operations of these interchanges, as well as mainline I-495 itself, in the morning and afternoon peak hours are then analyzed in terms of traffic volume demands.

For discussion purposes, the corridor has been divided into a Western Segment that extends between the western study limit at the Westford/Littleton town line to I-93 in Andover, and an Eastern Segment that continues from I-93 in Andover to I-95 in Salisbury.

This section (2.3.1) also discusses travel time runs, crash data, public transportation, park and ride facilities, transportation management associations, and Intelligent Transportation Systems. It is followed by sections on land use, socio-economics, and the natural environment.

2.3.1.1 I-495 and its Interchanges

I-495 Mainline

As stated in Chapter 1, the section of I-495 under study for this project begins at the Westford/Littleton town line and ends at the highway's northern terminus at its junction with I-95 in Salisbury. Within this 40-mile-long study corridor, I-495 provides three 12-foot travel lanes in each direction between Westford and State Route 110 in Amesbury, and two 12-foot travel lanes between State Route 110 and Route I-95 in Salisbury. I-495 also provides one 10-foot shoulder on the inside lane and one 4-foot shoulder next to the outside lane for the entirety of the study area. Truck travel along I-495 is restricted to the two right-hand travel lanes. The posted speed limit is generally 65 miles per hour throughout the corridor except a for section of highway on either of the double-decker bridge in Lawrence where the speed limit is 55 miles per hour. There are 25 interchanges (Exits 32 through 55 plus the junction with I-95) connecting I-495 and abutting roadways within the study corridor.

Generally, the purposes of I-495's travel lanes are to process inter-regional travel demand through the study area, and to provide intra-regional connections for travel demands from the mainline to abutting roadways and land uses at interchanges. While travel on the mainline can be congested at

times, the majority of congestion and turbulence on the mainline is directly related to traffic entering and exiting I-495 at its interchanges. From this perspective, interchange operations at the junction of interchange ramps with the mainline and with local intersecting streets are critical to I-495 meeting both local and regional travel demands. The next section presents an overview of each of the study's 25 interchanges, which have a strong influence on I-495's mainline operations.

I-495 Interchanges

Characteristics of each of the interchanges are briefly summarized below. A MassGIS/MassHighway color orthophoto or an aerial photograph taken by Fay, Spofford & Thorndike is included with a brief summary of each interchange.

Interchange 32

Location:	Westford
Cross-Street:	Boston Road
Type:	Full Diamond
Signalized:	Yes
Comments:	Offset intersections west of I-495

Interchange 33

Location:	Chelmsford
Cross-Street:	State Route 4 (North Road)
Type:	Partial Diamond
Signalized:	No
Comments:	No access to I-495 north and from I-495 south

Interchange 34

Location: Chelmsford
Cross-Street: State Route 110 (Chelmsford Street)
Type: Partial Cloverleaf
Signalized: No
Comments: None

Interchange 35

Location: Chelmsford @ Lowell city line
Cross-Street: U.S. Route 3
Type: Full Cloverleaf
Signalized: No
Comments: All ramps connect to/from parallel service roads on both I-495 and U.S. Route 3. U.S Route 3 was recently reconstructed in this area.

Interchange 36

Location: Lowell
Cross-Street: Lowell Connector
Type: Directional Trumpet
Signalized: No
Comments: All ramps connect to/from parallel service roads on I-495

Interchange 37

Location:	Lowell
Cross-Street:	Woburn Street
Type:	Full Diamond
Signalized:	No
Comments:	One leg of diamond uses a local street (Christman Avenue) as an on-ramp

Interchange 38

Location:	Tewksbury
Cross-Street:	State Route 38 (Main Street)
Type:	Combination Partial Cloverleaf/Diamond
Signalized:	Yes
Comments:	None

Interchange 39

Location:	Tewksbury @ Andover town line
Cross-Street:	State Route 133 (Andover Street/Lowell Street)
Type:	Partial Cloverleaf
Signalized:	Yes
Comments:	None

Interchange 40

Location:	Andover
Cross-Street:	I-93
Type:	Full Cloverleaf
Signalized:	No
Comments:	None

Interchange 41

Location:	Andover
Cross-Street:	State Route 28 (North Main Street & Union Street)
Type:	Combination Partial Cloverleaf/Partial Directional
Signalized:	No
Comments:	None

Interchange 42

Location:	Lawrence
Cross-Street:	State Route 114 (Winthrop Avenue)
Type:	Partial Cloverleaf
Signalized:	Yes
Comments:	None

Interchange 43

Location: North Andover @ Lawrence city line
Cross-Street: Massachusetts Avenue/Loring Street
Type: Full Diamond
Signalized: No
Comments: None

Interchange 44

Location: Lawrence @ North Andover town line
Cross-Street: Merrimack Street & Sutton Street
Type: Partial Diamond
Signalized: Yes*
Comments: No access to I-495 south and from I-495 north

*Signalized after 2006 traffic data collected, so treated as unsignalized for existing conditions analyses

Interchange 45

Location: Lawrence
Cross-Street: Marston Street
Type: Directional Interchange
Signalized: No
Comments: None

Interchange 46

Location:	Methuen
Cross-Street:	State Route 110 (Merrimack Street)
Type:	Combination Partial Cloverleaf/Partial Diamond
Signalized:	Yes
Comments:	None

Interchange 47

Location:	Methuen
Cross-Street:	State Route 213 (Albert Slack Hwy)
Type:	Directional Trumpet
Signalized:	No
Comments:	None

Interchange 48

Location:	Haverhill
Cross-Street:	State Route 125
Type:	Combination Partial Cloverleaf/Partial Directional
Signalized:	No
Comments:	None

Interchange 49

Location:	Haverhill
Cross-Street:	State Routes 110/113 (River Street)
Type:	Combination Partial Cloverleaf/Partial Diamond
Signalized:	No
Comments:	Majority of ramps connect to/from parallel service roads on I-495

Interchange 50

Location:	Haverhill
Cross-Street:	State Route 97 (Broadway)
Type:	Partial Cloverleaf
Signalized:	Yes
Comments:	All ramps connect to/from parallel service roads on I-495

Interchange 51

Location:	Haverhill
Cross-Street:	State Route 125 (Main Street)
Type:	Full Cloverleaf
Signalized:	No
Comments:	Ramps on the north side of I-495 connect with parallel service road

Interchange 52

Location:	Haverhill
Cross-Street:	State Route 110 (Amesbury Road)
Type:	Partial Cloverleaf
Signalized:	No
Comments:	None

Interchange 53

Location:	Merrimac
Cross-Street:	Broad Street
Type:	Full Diamond
Signalized:	No
Comments:	None

Interchange 54

Location:	Amesbury
Cross-Street:	State Route 150
Type:	Combination Partial Cloverleaf/Partial Diamond
Signalized:	No
Comments:	None

Interchange 55

Location: Amesbury
Cross-Street: State Route 110 (Macy Street)
Type: Combination Partial Cloverleaf/Partial Diamond
Signalized: No
Comments: No access to I-495 north and from I-495 south

Junction of I-495 with I-95

Location: Salisbury
Cross-Street: I-95
Type: Partial Diamond
Signalized: No
Comments: No access from I-495 north to I-95 south and from I-95 north to I-495 south

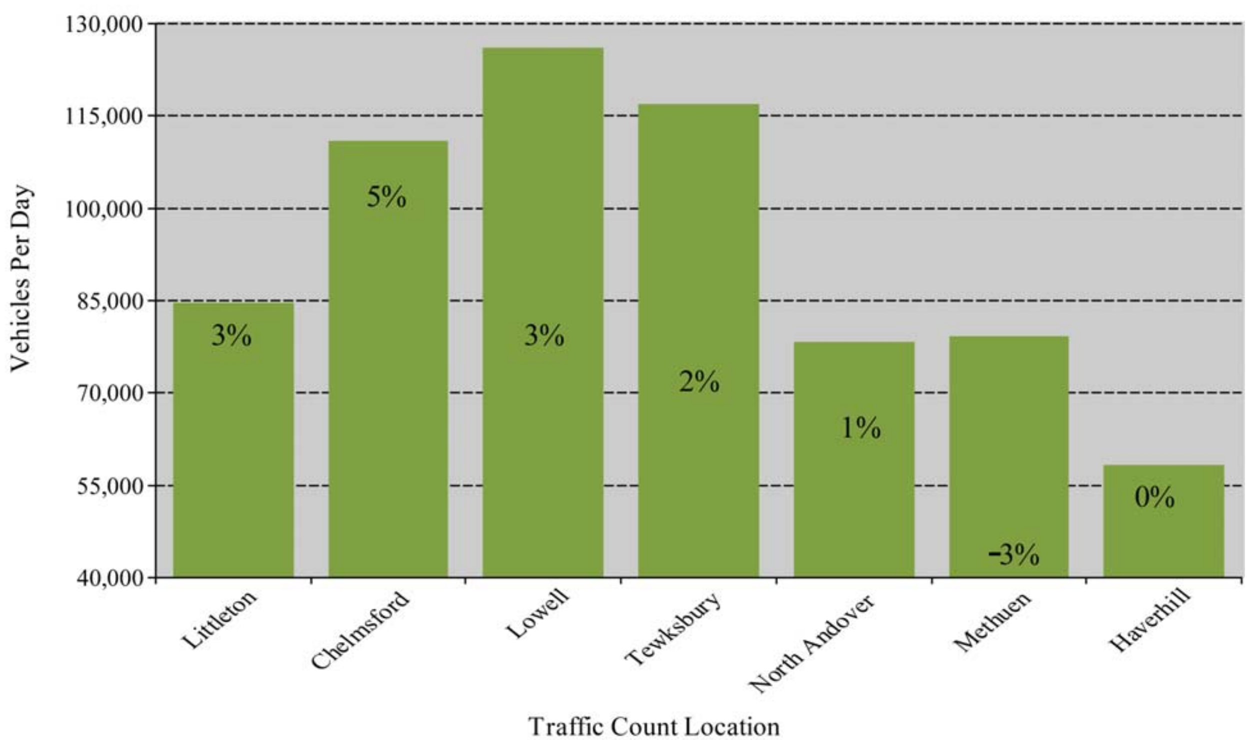
2.3.1.2 Traffic Volumes

2004 Mainline and Intersection Traffic Volumes

The length of the study corridor—coupled with the fact that it traverses multiple distinct communities—creates a dynamic traffic scenario that is evident in the varied traffic growth rates and volumes along the corridor. Figure 2-1 illustrates both the fluctuations in growth rates and the changes in traffic volumes along the corridor, progressing from west to east. The bars represent the largest recorded volume for that specific location between 1998 and 2002. The percentages were derived from traffic volume data collected from 8 permanent count stations along I-495 between 1998 and 2002. Volumes were then analyzed on a straight-line basis to determine the approximate annual average growth rate.

It is also useful to show long-term historic traffic volumes and growth rates on several sections of I-495 to see how they have changed over the years. For example, Figure 2-2a shows that, at a location on I-495 in Chelmsford on the western end of the study corridor, to the south of State Route 4, the average daily traffic volume in 1962 was 6,300 vehicles per day and in 1972 was 33,400 vehicles per day. By 1982, traffic here had increased to 43,100 vehicles per day, representing a 29 percent increase over that 10-year period. It had reached 75,500 vehicles per day by 1992 (a further 75 percent increase over 10 years) and 110,900 vehicles per day by 2002 (a 47 percent increase since 1992). Over the 30-year period between 1972 and 2002, a 232 percent increase in traffic volumes was experienced along this section of the highway. The latest available count for 2006 shows 113,100 vehicles per day, indicating that traffic volume continues to grow.

Figure 2-1
Traffic Volumes and Growth: Annual Average Daily Traffic Volume (1998-2002)



Looking at this same location in Chelmsford from another perspective, in the 20-year period between 1962 and 1982, daily traffic increased by close to 40,000 vehicles per day. Over the next 20-year period between 1982 and 2002, it grew by close to 70,000 vehicles per day.

ADT from 1962 – 2005 on I-495 in Chelmsford, South of Route 4

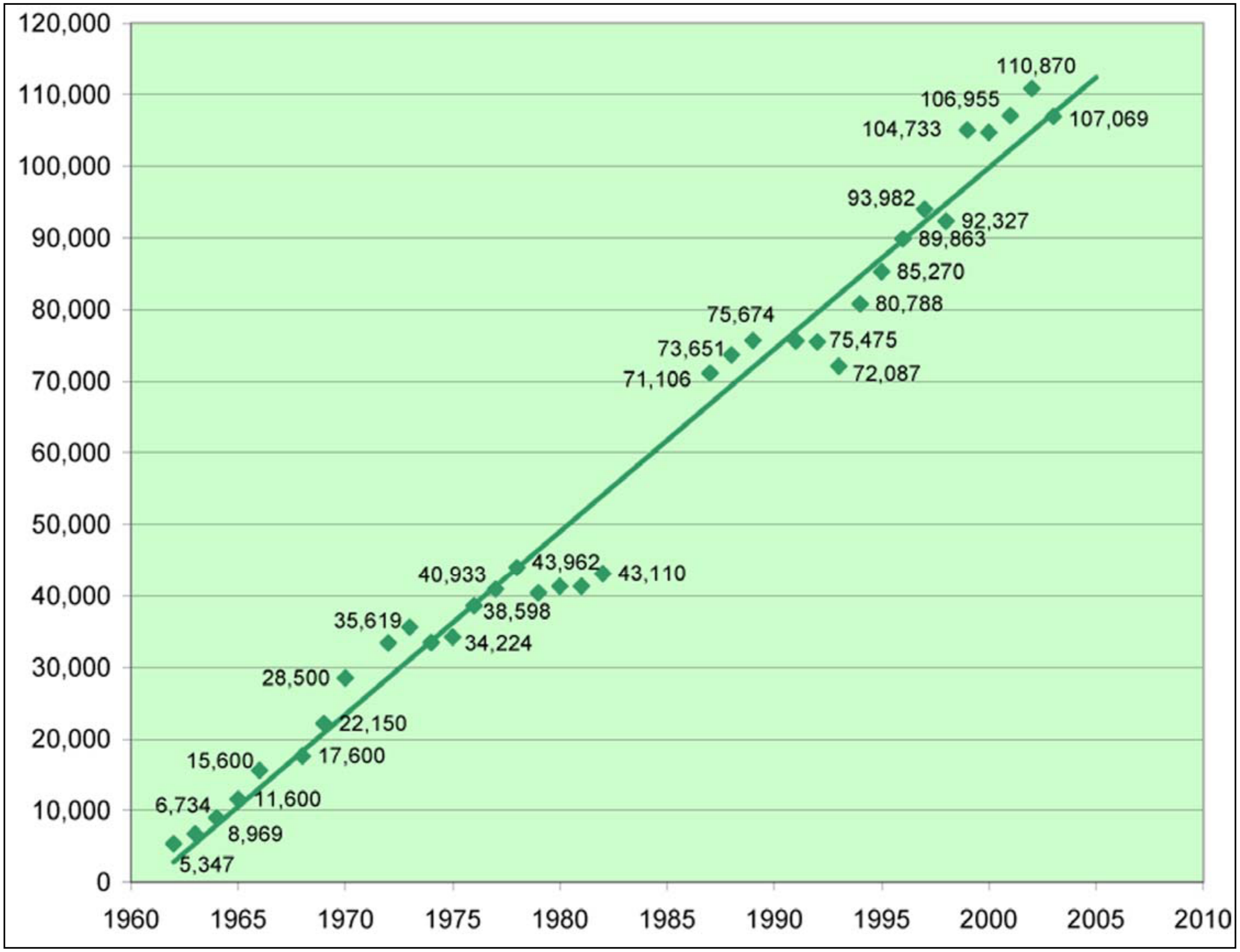


Figure 2-2a
ADTs from 1962 – 2005 on I-495 in Chelmsford, South of Route 4

At the Andover/Lawrence municipal line in the central part of the study area, Figure 2-2b shows that the average daily volume on this section of I-495 in 1972 was 45,600 vehicles per day. By 1982, it had increased to 65,000 vehicles per day, a 43 percent increase over 10 years. A daily volume of 84,500 in 1992 at this same location represented a 30 percent increase over 10 years. By 2000, daily volume here had increased to 95,700 vehicles.

Again, looking at growth along this section of roadway over 20-year increments, beginning in 1964 shortly after it opened, daily traffic was approximately 20,000 vehicles. Twenty years later in 1984, it had increased to approximately 62,000 vehicles per day, an increase of 42,000 daily vehicles over the 20-year period. The following 20-year period, from 1984 to 2004, saw daily traffic increase from 62,000 vehicles to 106,500, another increase of 44,000 daily vehicles.

At the eastern end of the study corridor in Amesbury at the Merrimac town line, Figure 2-2c shows that the average daily volume in 1972 was 23,500 vehicles per day. It had increased to 29,200 by 1982 and to 51,000 by 1992, representing increases of 24 percent and 75 percent, respectively, for each of those 10-year periods. By 2002, the daily volume had reached 62,500 vehicles, a further 23 percent increase. Between 1972 and 2002, average daily traffic volume at this particular location increased by 166 percent.

As with the two previous locations just discussed, it is of interest to look at traffic here in terms of growth over 20-year periods. From 1972 to 1992, daily traffic grew from 23,500 vehicles to 51,000 vehicles, an increase of 27,500 vehicles. Between 1982 and 2002, daily traffic grew from 29,200 vehicles to 62,500 vehicles, an increase of 33,300 vehicles. Thus, growth in traffic volumes over these two 20-year periods was in the 30,000 vehicle-range in each case.

More recently, traffic volumes were collected during the fall of 2004 and the spring of 2006 by the Massachusetts Highway Department (MassHighway). The 2004 numbers are based on 24-hour automatic traffic recorders (ATR) data from the I-495 mainline. The 2006 numbers represent weekday peak hour manual-turning-movement (MTM) counts and vehicle classification determinations obtained for all locations where the interchanger ramps intersect with local streets. (See Table B-1 in Appendix B for an itemized list of the 2006 MTM count locations along the study corridor.) The ATR and MTM data was seasonally adjusted to reflect average weekday traffic volume conditions. Figures 2-3 and 2-4 show the Average Weekday Daily Traffic (AWDT) as well as peak AM and PM directional counts along the mainline, while Figures 2-5 through 2-8 represent the AM and PM peak hour turning movements at study area interchanges.

ADT from 1962 – 2005 on I-495 at Andover/Lawrence Municipal Line

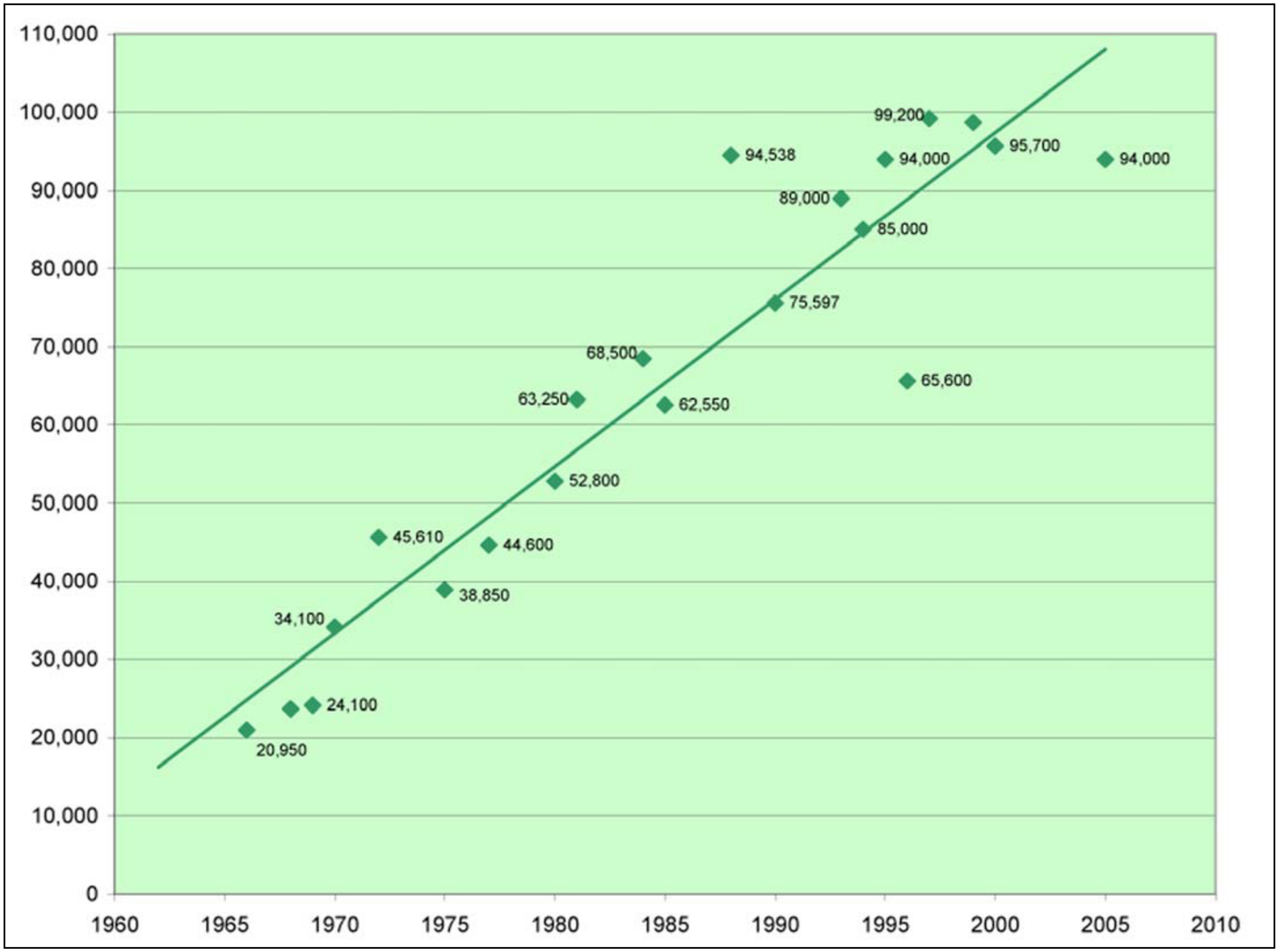


Figure 2-2b
ADTs from 1962 – 2005 on I-495 at Andover/Lawrence Municipal Line

ADT from 1962 – 2005 on I-495 at Amesbury/Merrimac Town Line

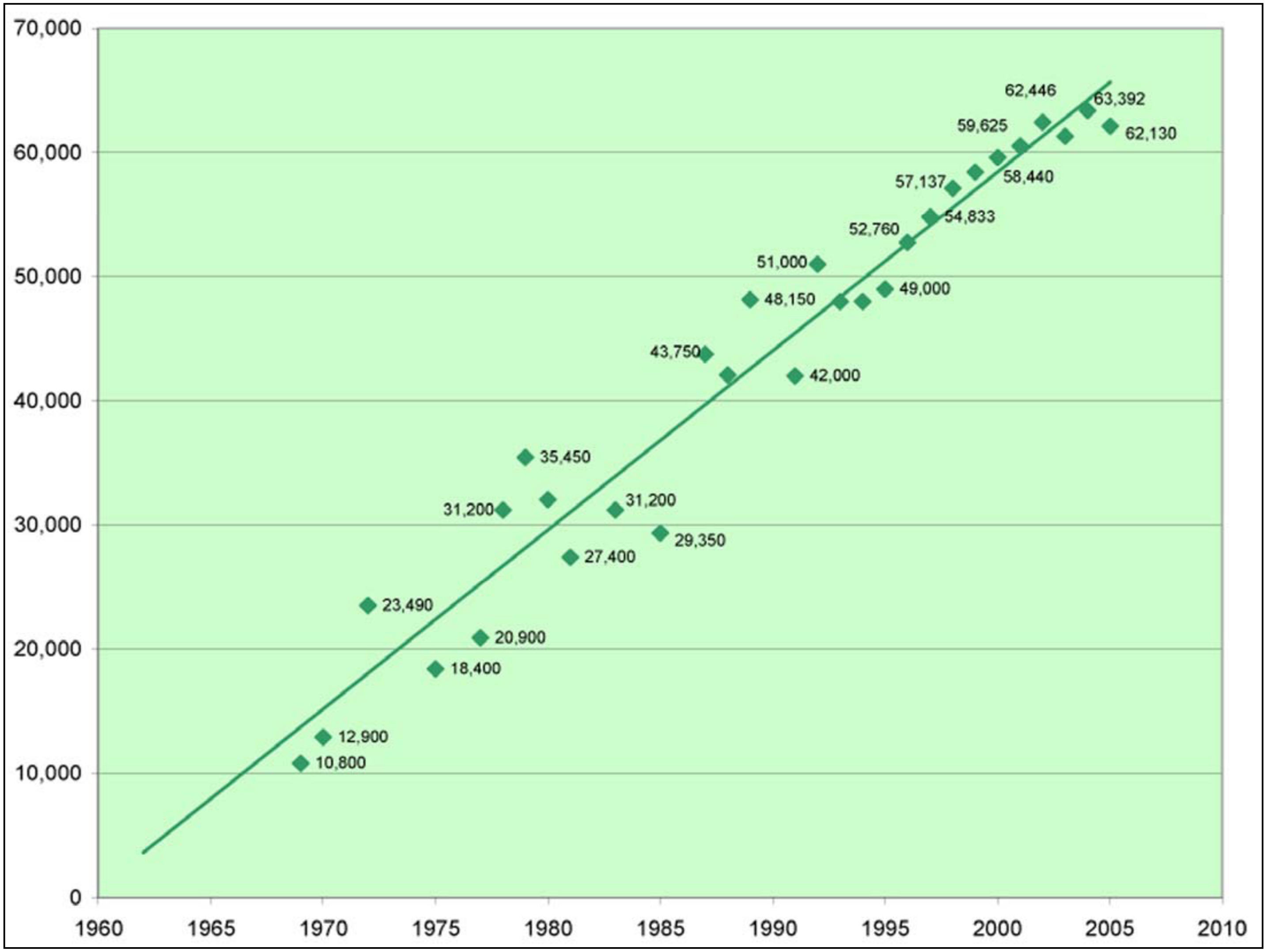


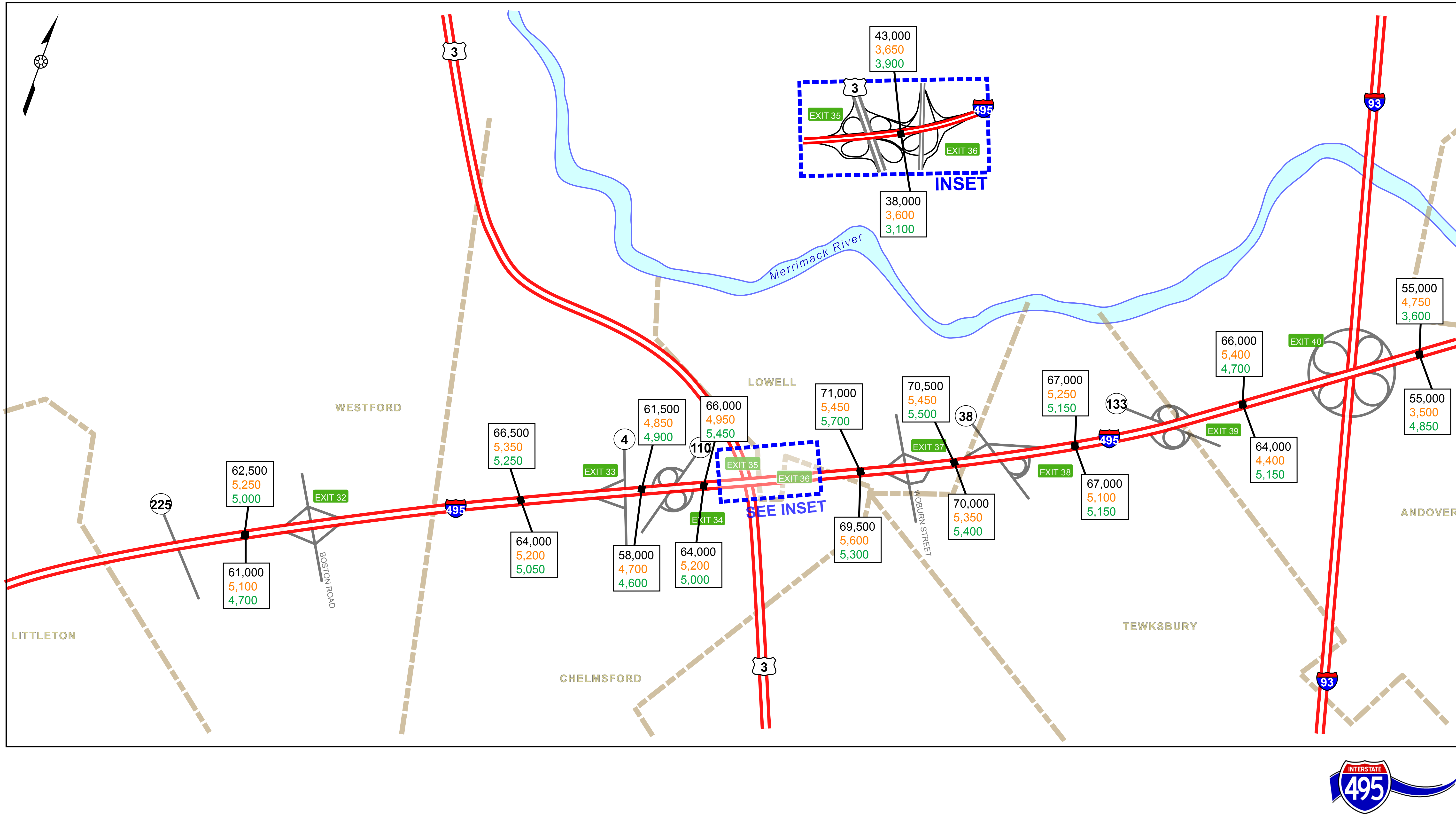
Figure 2-2c
ADTs from 1962 – 2005 on I-495 at Amesbury/Merrimac Town Line

Based on the data, it is apparent that traffic volumes are generally more concentrated in the Western Segment of the corridor than in the Eastern Segment. The AWDT numbers in Figures 2-3 and 2-4 illustrate that, overall, eastbound traffic volumes tend to decline from west to east, while westbound traffic volumes grow from east to west. The exceptions to this pattern come at locations where other major arteries running north-south bisect I-495, specifically at Exits 35, 36, and 40, where U.S. Route 3, the Lowell Connector, and I-93 interchange with I-495, respectively. Traffic close to these interchanges tends to be relatively heavier. For eastbound traffic, volumes dramatically increase just east of U.S. Route 3, indicating that this north-south artery is a large source of eastbound traffic for I-495. In the westbound direction, volumes increase just west of State Route 125 and I-93, indicating that these are both major sources for westbound traffic.

With regard to specific AWDT traffic volumes, Figures 2-3 and 2-4 show that, in the eastbound direction, the 2004 AWDT at the far western end of the study corridor is 61,000 vehicles per day. AWDT in the eastbound direction hits its peak at 69,500 vehicles per day between Exits 36 and 37 in Lowell. At the far eastern end of the study corridor, eastbound traffic decreases to only 22,000 vehicles per day. A similar pattern with regard to AWDT exists in the westbound direction. Specifically, at the far eastern end of the study area, the 2004 AWDT is 23,000 vehicles per day westbound, while at the far western end it is 62,500 vehicles per day in the westbound direction. As with the eastbound direction, the westbound AWDT peaks between Exits 37 and 36 in Lowell, in this case at 71,000 vehicles per day. Accordingly, the two-way AWDT at this location in Lowell is 140,500 vehicles per day.

Figures 2-3 and 2-4 show interesting pattern variations with regard to peak hour traffic volumes between the Western Segment of the study area and the Eastern Segment. Specifically, observing Figure 2-2 one can see that, in the Western Segment of the study area for both the AM and PM peak hours, the directional flows are close to being in balance. That is, there is approximately the same number of vehicles traveling in one direction on I-495 as in the other. However, as Figure 2-4 illustrates, this is not the case within the Eastern Segment of the study area. During the AM peak hour, traffic volumes in the westbound direction substantially exceed those in the eastbound direction. During the PM peak hour, the opposite holds true.

Other general patterns exist, as well. Eastbound traffic tends to be lower in the AM peak hour than in the PM peak hour throughout the length of study corridor. Conversely, westbound traffic tends to be higher in the AM peak hour than in the PM peak hour, especially in the Eastern Segment of the study corridor. This imbalanced flow between AM and PM peak hours indicates a large commuter presence on the study corridor.

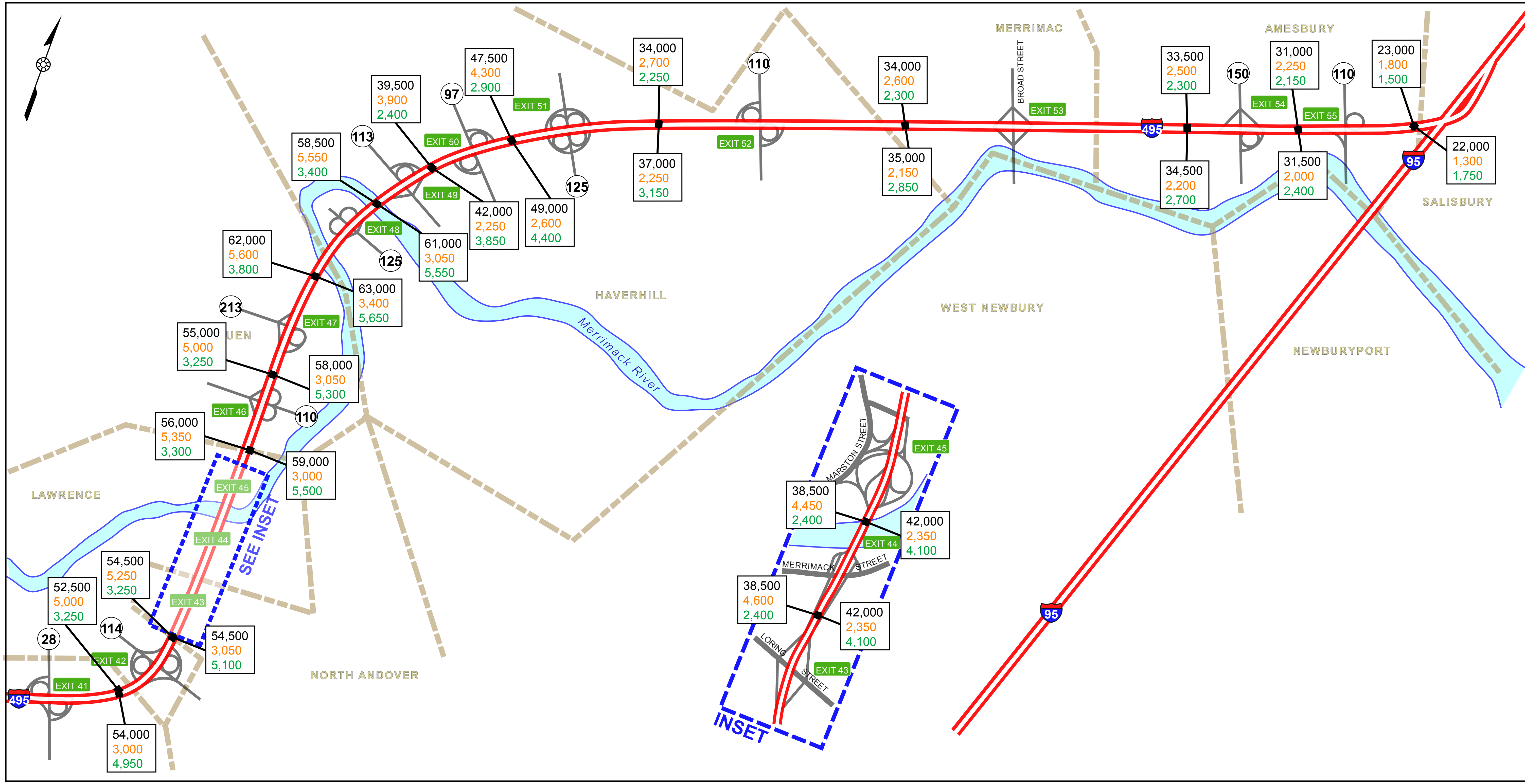


Legend

Average Daily Traffic Volume
AM Peak Hour Directional Volume
PM Peak Hour Directional Volume

Figure 2-3*
2004 Average Weekday Daily Traffic and
2006 AM and PM Peak Directional Volumes
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend
Average Daily Traffic Volume
AM Peak Hour Directional Volume
PM Peak Hour Directional Volume

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

Figure 2-4*
2004 Average Weekday Daily Traffic and
2006 AM and PM Peak Directional Volumes
Eastern Segment

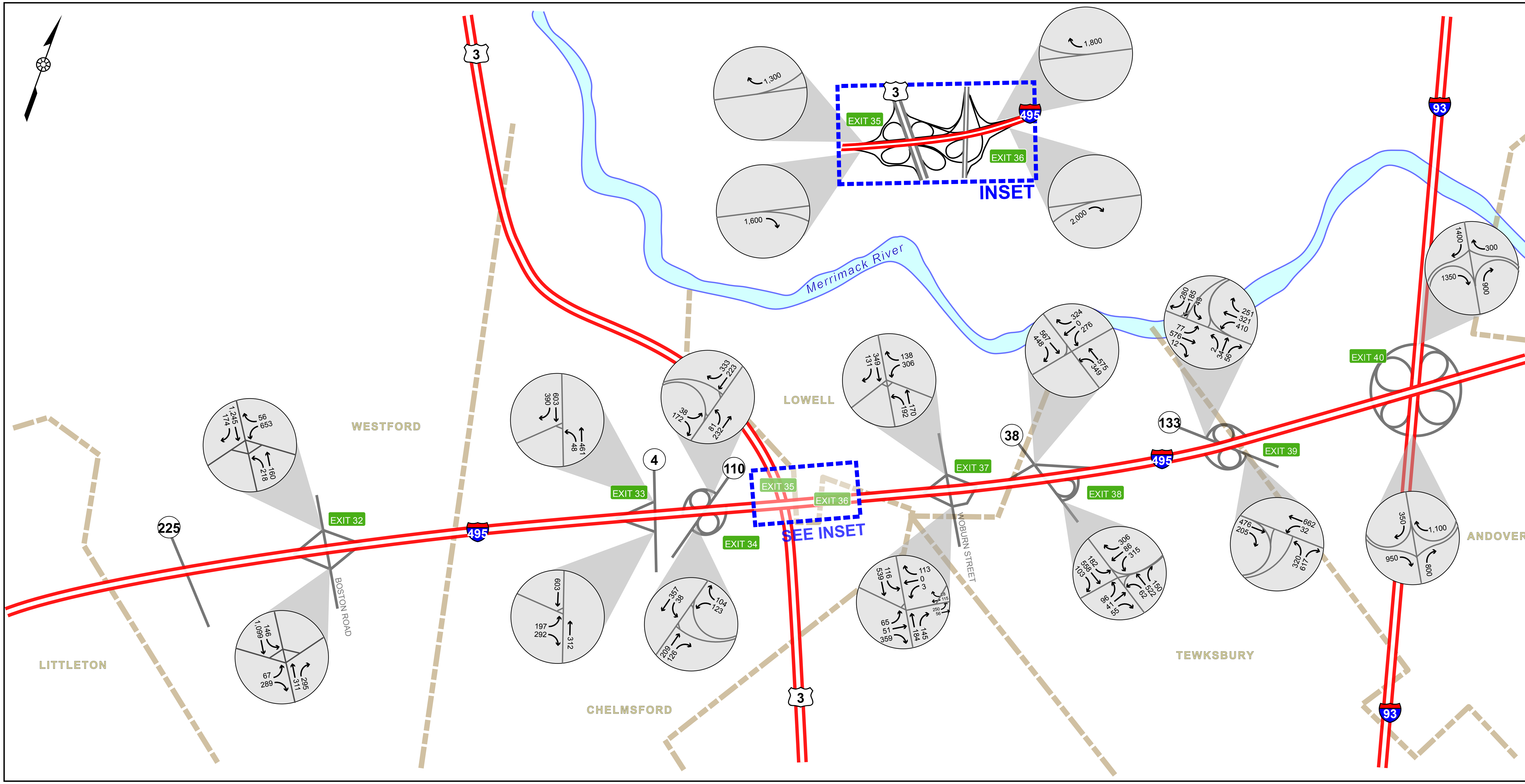


Figure 2-5*
2006 AM Peak Hour Volumes
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

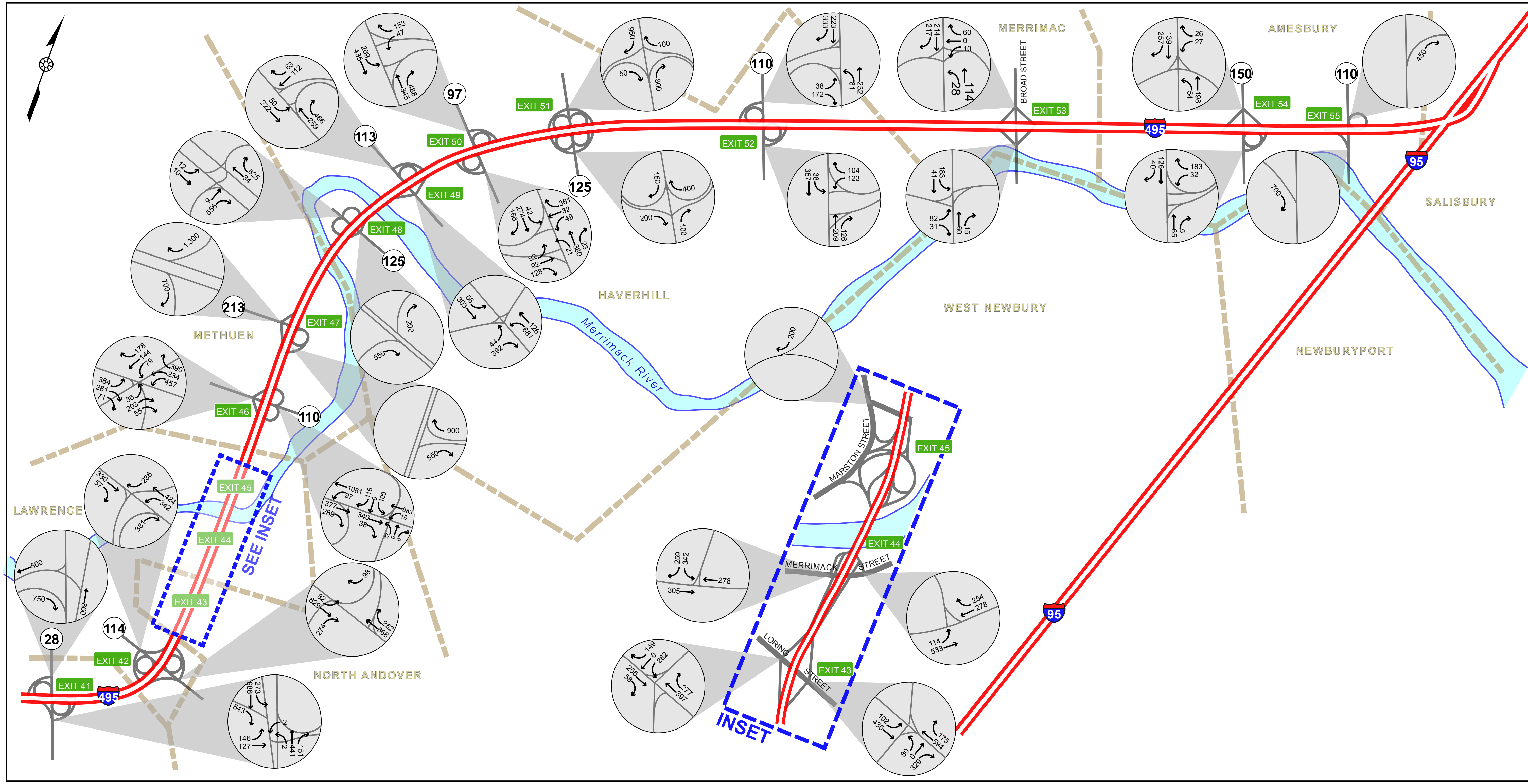


Figure 2-6*
2006 AM Peak Hour Volumes
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

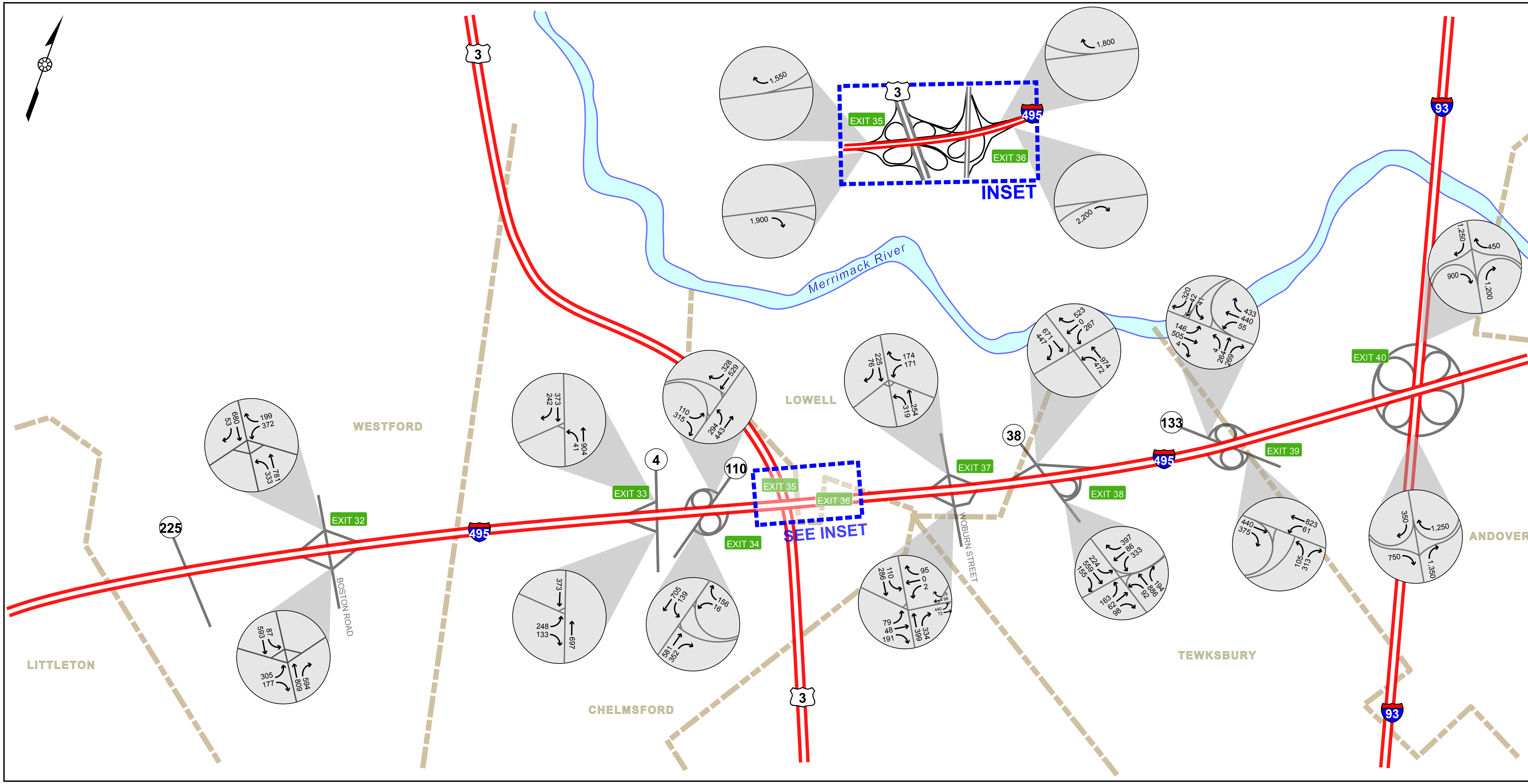


Figure 2-7*
2006 PM Peak Hour Volumes
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

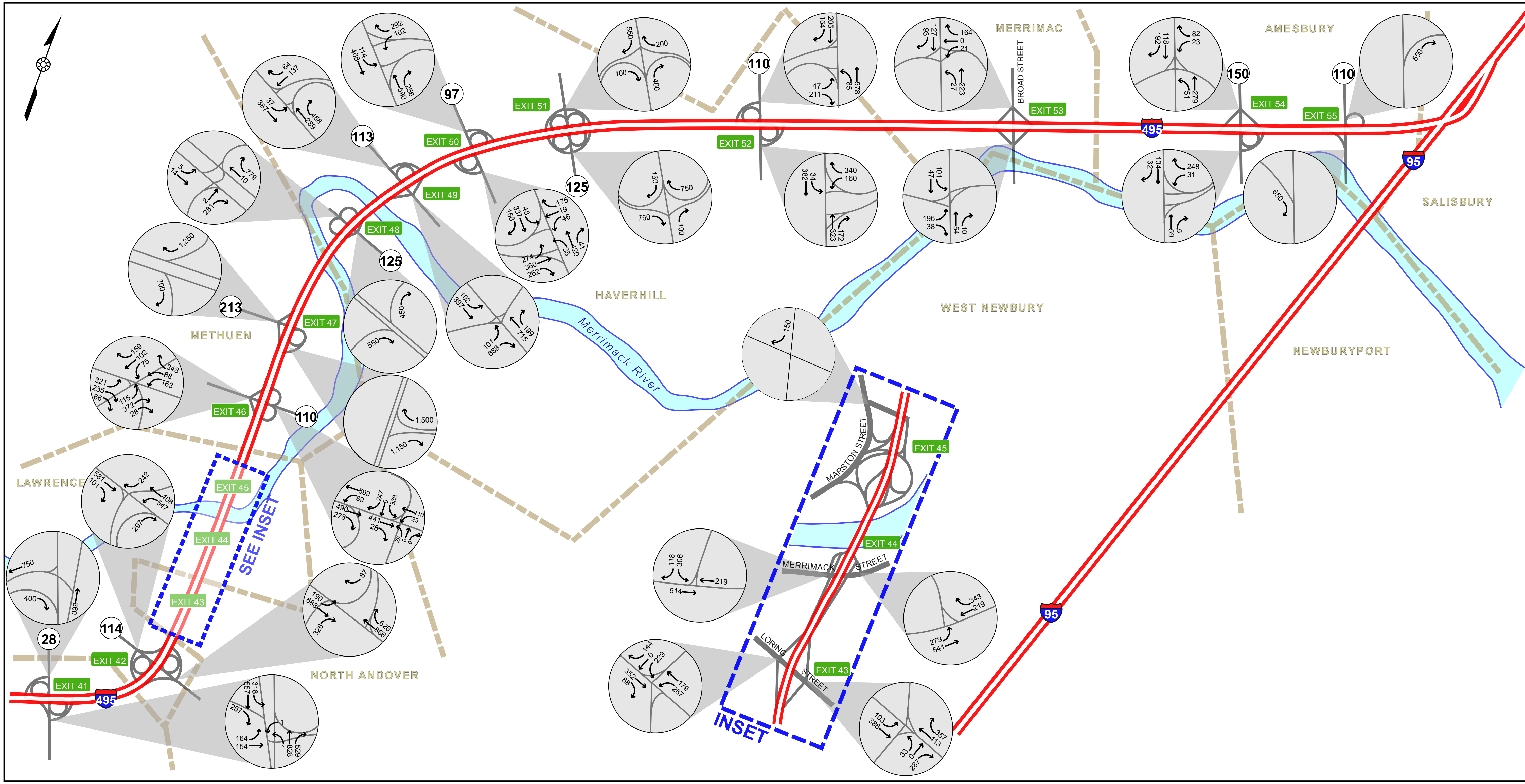


Figure 2-8*
2006 PM Peak Hour Volumes
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

Differences in peak hour volumes are also of interest. During the AM peak hour in the eastbound direction it can also be seen from Figures 2-3 and 2-4 that directional volumes range from 5,100 in Westford to only 1,300 at the far eastern end of the study corridor in Amesbury. In the opposite (i.e., westbound) direction, AM peak hour volumes range from 1,800 in Amesbury to 5,250 in Westford.

In the eastbound direction, the AM peak hour volume was found to reach its greatest value, 5,600 vehicles per hour, between Exits 36 and 37 in Lowell. This is also the same location where AWDT reaches its greatest value in the eastbound direction. However, in the westbound direction during the AM peak hour, the maximum value of 5,450 vehicles per hour occurs at two adjacent highway links, namely between Exits 38 and 37 and between Exits 37 and 36, both of which are in Lowell.

During the PM peak hour, Figures 2-3 and 2-4 show that the eastbound direction volume is 4,700 vehicles per hour in Westford at the far western end of the study corridor, and 1,750 vehicles per hour in Amesbury at the far eastern end. Westbound PM peak hour volumes are 1,500 in Amesbury and 5,000 in Westford. Between Exits 37 and 36 in Lowell, westbound PM peak hour volumes have their greatest value at 5,700 vehicles per hour. Again, westbound AWDT volumes also have their greatest value at this same location.

It should be noted that the traffic volumes presented and discussed in this Chapter represent average annual conditions. However, it is recognized that traffic volumes do vary according to season and by day of the week. Accordingly, at the request of the corridor's two regional planning agencies, a review was carried out to determine the characteristics of these traffic variations at three locations along mainline I-495. These locations were at State Route 4 in Chelmsford, State Route 133 in Tewksbury, and the Amesbury/Salisbury town line. Multiple combinations of traffic scenarios were examined, including typical weekday AM and PM peak periods, mid-day peak periods on weekend days, AM and PM peak periods on Thursdays and Fridays, etc.

Traffic counts from these three locations do show seasonal and daily variations of traffic on I-495. For example, at the Amesbury location, traffic during the summer was determined to be greater than that during the spring and/or the fall for typical weekday peak periods, weekend mid-day peak periods, and Thursday and Friday peak periods. The summer season also was determined to dominate at the Tewksbury location, but to a lesser degree than at Amesbury. At the Chelmsford location, fall traffic dominated compared with other seasons for typical weekday peak periods, while summer traffic was determined to dominate during the weekend mid-

day peak periods. During the Thursday and Friday peak hour periods at Chelmsford, there was little difference in traffic during the summer when compared with other seasons.

In other examples of what was determined, at the Amesbury location, the heavier traffic during the summer has little or no effect on highway LOS when compared with an average day, with operating conditions remaining uncongested. On the other hand, at the Chelmsford location, it was determined that, for northbound I-495, the heavier traffic during the AM and PM peak hours during the summer results in congested LOS F conditions compared with LOS D on an average day.

A detailed memorandum regarding the results of this review of seasonal traffic variations can be found in Appendix B of this document. However, it is very important to recognize that it is not standard practice to plan and design for the extremes, particularly when those extremes might occur only a limited number of times per year. Rather, as noted above, all traffic volumes and, thus, LOS analyses, presented in this report represent average yearly conditions.

Freight and Goods Movement

Freight trucks also make up a large percentage of I-495 traffic within the study corridor. Based on 2005 MassHighway vehicle classification data from the permanent count station located on I-495 in Amesbury, trucks on I-495 represent 18 percent of average daily traffic. While this percentage is unusually high in and of itself, it is deceptive in that trucks are only allowed in the two right-hand lanes on I-495, accordingly making the actual percentage of trucks using these lanes on a daily basis greater than 18 percent.

Counts of truck volumes on I-495 at several key locations along the study corridor were also undertaken by staff members of the Merrimack Valley Planning Commission and the Northern Middlesex Council of Governments during 2007. These counts were directional (eastbound and westbound) in nature and were taken during the AM and PM peak periods. The resulting volumes were then compared with total peak period traffic volumes at these same locations to determine the percentage of peak period truck traffic.

Four count locations were selected, which were taken by individuals stationed on bridge overpasses looking down at the traffic below on I-495. Specifically, the count locations were at Hunt Road (Link 32-33) in Chelmsford, Trull Road (Link 38-39) in Tewksbury, Chandler Street (Link 40-41) in Andover, and Locust Street (over Link 52-53) in Merrimac.

The truck percentages at the specified locations are summarized in Table 2-1.

As can be seen in Table 2-1, the percentage of trucks during the AM peak hour, with one exception, always exceeded the percentage of trucks during the PM peak hour, in both directions at all four count locations. The one exception was at the Locust Street overpass in Merrimac in the westbound direction. The highest number of trucks was at Hunt Road in Chelmsford on the far western end of the study area, where over 500 trucks in each direction were counted during the AM peak hour. The data above shows that, in general, the percentage of trucks counted decreased from west to east during in both directions during both the AM and PM peak hours.

Table 2-1
Percentages of Trucks in I-495 Study Area

	AM		PM	
	NB	**SB**	**NB**	**SB**
Hunt Road (Link 32-33)	10%	10%	6%	5%
Trull Road (Link 38-39)	9%	8%	5%	6%
Chandler Road (Link 40-41)	10%	6%	4%	6%
Locust Street (Link 52-53)	14%	8%	4%	8%
Average (West of I-93)	9.5%	9.0%	5.5%	5.5%
Average (East of I-93)	12.0%	7.0%	4.0%	7.0%

Specifically, the percentage of trucks on the road was consistently greater during the AM peak hour than the PM peak hour. During the AM peak hour, truck percentages were greater in the eastbound direction than in the westbound direction. The opposite was generally found to be true during the PM peak hour. The highest percentage of trucks occurred during the AM peak hour in the eastbound direction at Locust Street in Merrimac, where approximately 14 percent of all vehicles on I-495 headed in that direction were found to be trucks. It must be noted, however, that this percentage is somewhat deceiving as this same location was also determined to have the lowest actual truck count in the eastbound direction in the AM peak hour. The high percentage results from the relatively low number of non-truck vehicles traveling on this section of roadway at that time.

The MassHighway website was consulted regarding truck percentages on similar-type highways elsewhere in the Commonwealth. While peak period data is presented, no distinction is made as to whether the peak period given in the data is AM or PM. Nevertheless, a few sample data points from locations throughout the state are presented in Table 2-2.

As shown in the table below, in general the peak period truck percentages at these locations are less than those recently observed on I-495 in the study area. The key exception to this statement is on I-84 in Sturbridge at the Connecticut state line where 18 percent of the peak period traffic in 2006 was trucks. This particular location consistently produced truck percentages in the 15 to 20 percent range over a multi-year period covered by MassHighway's data collection efforts.

Table 2-2
Peak Period Truck Percentages at Selected Locations on Major State Highways

		Year	Percent Trucks
I-91	Bernardston	2006	10%
Rte. 3	Billerica	2006	2%
I-95	Canton	2006	2%
Rte. 3	Chelmsford	2006	3%
I-195	Fall River	2005	3%
Rte. 2	Fitchburg	2006	7%
I-95	Peabody	2006	3%
I-93	Quincy	2006	3%
I-95	Salisbury	2006	4%
I-84	Sturbridge	2006	18%
I-93	Woburn	2003	2%

The section of I-495 comprising this study's area of interest plays an important role in providing a path for regional and interstate movement of goods. This role is reflected in the above average truck percentages found along this section of highway.

Additional information regarding truck traffic can be found in a memo contained in Appendix B of this document.

Existing traffic volumes of all vehicle types indicate that a large demand currently exists on the Western Segment of I-495. When this data is considered in conjunction with the existing levels of service at the interchanges along the corridor, it becomes apparent that if baseline traffic volume growth continues at these same rates, the existing design of I-495 will experience volumes well above its capacity in the future.

2.3.1.3 Travel Time Runs

The Central Transportation Planning Staff (CTPS) conducted travel time runs between selected interchanges along the I-495 corridor between 1999 and 2000 and between 2004 and 2005. Figure 2-9 details the travel time data compiled from the travel time runs. Based on these runs, CTPS was able to generate average speeds for I-495 between State Route 2 in Littleton and State Route 110 in Amesbury. In general, average speeds from the 2004-2005 study are slower than those from 1999-2000. However, the numbers do reflect the same general pattern, indicating that the differences in speeds may be a reflection of the specific driving habits of the individuals conducting the study and not an indication of congestion.

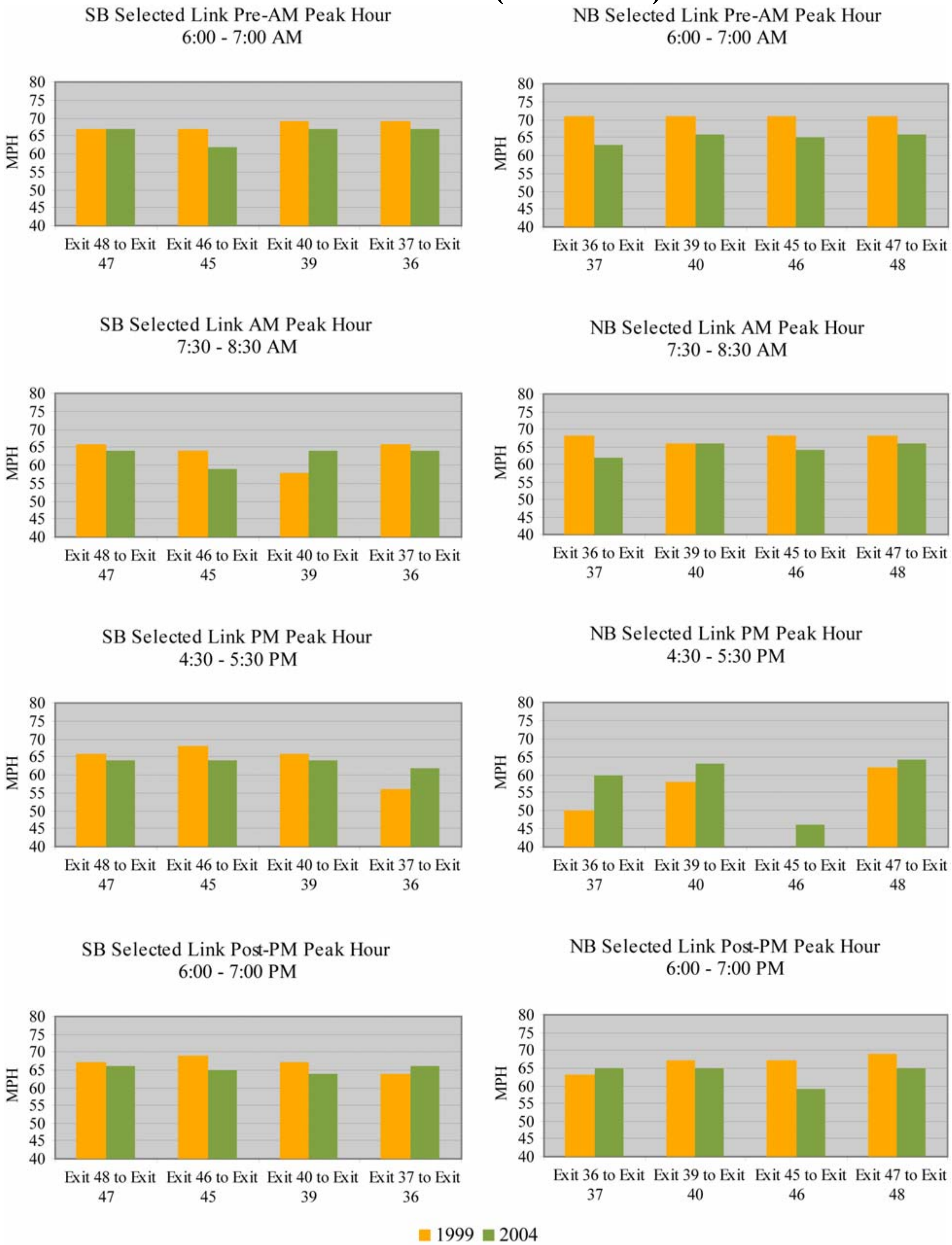
With few exceptions, the travel time data indicates that traffic is moving at or above the posted speed limits along the I-495 corridor. Northbound traffic slows down in the PM peak hour – most notably between Exit 45 and Exit 46, where it slows to 40 mph in 1999 and 46 mph in 2004. Likewise, southbound traffic speeds are particularly slow in the AM peak hour. Also not surprisingly, traffic travels at higher speeds prior to the AM peak hour and immediately following the PM peak hour than during either peak hour. However, due to the elevated level of traffic in the PM time frame, post-PM peak speeds are somewhat slower than pre-AM peak speeds. These findings are consistent both with the 2004 traffic volume data provided by CTPS and the volume data collected in 2006.

2.3.1.4 Traffic Operations Analysis Criteria

Level of Service (LOS), identified in the Highway Capacity Manual (HCM, 2000 Edition),[1] is a commonly accepted measure of efficiency for peak hour traffic operating conditions. LOS accounts for such factors as automobile and truck volumes, roadway capacity, speeds, grades, traffic control devices, the progression of vehicular traffic flow along an arterial roadway, roadway types, roadway widths and geometric layouts, as well as anticipated delays. Levels of service range from A, the optimal condition, to F, the condition where traffic demands are beyond capacity or create excessive delay conditions. At LOS E and LOS F, roadway or intersection operations are typically regarded as 'undesirable'. Thus, LOS D has typically become a threshold between acceptable and undesirable peak hour traffic operations.

[1] Highway Capacity Manual, Transportation Research Board Special Report 209, 2000 Edition

Figure 2-9
CTPS Travel Time Runs (1999 and 2000)



Traffic operations within the corridor are defined by the performance of several different components characterized by either interrupted flow (signalized and unsignalized intersections) or uninterrupted flow (highway sections and ramp junctions). In recognition of the distinctly different nature of traffic flow and driver's expectations for these types of traffic facilities, LOS is based on average delay at intersections and on density for highway sections and ramps. This concept and the typical characteristics of various components that comprise the roadway network in the study area are explained further in the following paragraphs.

Traffic operations at *unsignalized two-way stop controlled intersections* are given LOS rankings based on conflicting traffic flows and anticipated control delays related to conflicting minor movement traffic flows. These conflicting flows are the vehicular turning movements at an intersection that potentially must yield the right-of-way to other traffic movements at an intersection. Examples of these conflicting movements would be left turns from a major street to a minor side street (across the opposing flow of traffic), or left and right turns from a minor street or side street to the major street.

LOS's are only given for conflicting movements at unsignalized intersections. LOS ranking at an ***unsignalized intersection*** is determined by calculating the average total delay in seconds per vehicle. Total delay is the total elapsed time from when a vehicle stops at the end of a queue until the time when a vehicle departs from the stop line and enters the traffic stream. This includes the time required for the vehicle to travel from the last-in-queue position to the first-in-queue position. The average total delay for any particular minor movement is a function of the traffic demand flow rate and the capacity of the approach based on the number of available gaps in the conflicting traffic stream. An average total delay of 10 seconds or less per vehicle is defined as LOS A. According to the 2000 Highway Capacity Manual, total delay of 50 seconds per vehicle is assumed to be the break point between LOS E and F. LOS F exists when there are an insufficient number of gaps in the conflicting traffic stream available to allow a minor movement to safely cross a supposedly unimpeded major street traffic movement.

Signalized intersections have different criteria for acceptable total delay than unsignalized intersections. At signalized intersections, higher total delay values are generally considered to be more acceptable than at unsignalized intersections. While the LOS A criteria is the same as at unsignalized intersections, LOS F involves 80 seconds of total delay – 30 seconds more than unsignalized intersections. The relationship between LOS and average total delay at signalized and unsignalized intersections is summarized in Table 2-3.

Table 2-3
Intersection Level of Service Criteria

Unsignalized Intersections	
Level of Service	**Average Total Delay Range (seconds/vehicle)***
A	≤10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	>50

Signalized Intersections	
Level Of Service	**Average Total Delay Range (seconds/vehicle)***
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

* Source: Highway Capacity Manual 2000. Difference in travel time between stopped plus acceleration and deceleration delays during the peak 15-minute period.

The LOS F designation at unsignalized locations involves 50 or more seconds of average total vehicle delay per vehicle and 80 or more seconds of delay at signalized locations.

Highway segments or ***Links*** are those limited access sections of I-495 between interchanges. In these areas there are no ramps and LOS is purely a function of vehicle density per lane, which provides a measure of the spacing between vehicles and the ability of a driver to travel at a desired speed without being impacted or delayed by other vehicles on the roadway.

Ramp junctions are those locations where traffic either merges with or diverges from the mainline traffic stream. ***Merge movements*** occur at those locations where vehicles entering I-495 from an on-ramp must blend with or merge into the mainline flow. ***Diverge movements*** occur as a vehicle maneuvers out of the mainline flow and onto an exit ramp. Similar to links, LOS for merge and diverge sections is a function of the density in the two right lanes on the I-495 mainline at the point of merge/diverge. The main traffic demands concerned are the merge or diverge traffic volumes and the mainline traffic volume. Capacity in these sections is reached when the combination of mainline through traffic and ramp traffic in the two right lanes equals 4,400 vehicles per hour at an off-ramp and 4,600 vehicles per hour at an on-ramp. Schematic depictions of merge and diverge movements are given on Figure 2-10. It should be noted that

lengthening an acceleration lane used for merging traffic or a deceleration lane use for diverging traffic so that they meet current standards will not improve the level of service a those locations but will serve to increase driver comfort and improve safety.

Weaving Sections occur in those locations where vehicles must change lanes within the traffic stream to continue on their desired path. One example of a weaving section typical of many locations along I-495 is between the inner loops of on-/off-ramps at a cloverleaf interchange. Traffic entering I-495 from the on-ramp must change lanes, "weaving" with traffic exiting I-495 to the off-ramp. Density in these locations is a function of weaving section length, number of lanes and the number of weaving vehicles. Poor LOS is typically indicative of conditions where weaving vehicles must reduce their speed to a point where it impacts the movement of through traffic on the mainline. Figure 2-10 referenced above also provides a schematic depiction of a weaving section. Note that in some cases, a weave may fail because there is not enough weaving length provided. In other cases, a weave may fail even if there is more than sufficient weave length, with volume being the controlling factor. Some weave failures may require the complete redesign of an interchange to avoid such a failure.

It is important to note that, because of the distance between study interchanges, peak hours vary from location to location. Generally speaking, in this study, the AM peak hour for a given interchange begins sometime between 7:30 and 8:00 AM and the PM peak hour between 4:30 and 5:00 PM.

2.3.1.5 Existing (2006) Peak Hour Traffic Operations

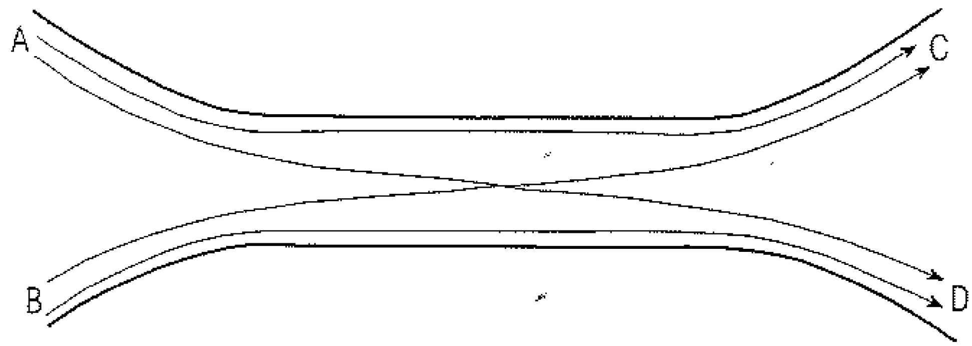
Existing (2006) traffic operating conditions along the study corridor are discussed in this section with regard to levels of service at unsignalized and signalized intersections; at merge, diverge, and weave locations; and for links on I-495. A series of accompanying Figures presents the results of these analyses in a graphical format and supplements the text material.

More detailed information about the analysis results can be found in Appendix B, Tables B-2 through B-7 in which such additional information as delay and queue length are presented at each intersection on a movement-by-movement basis.

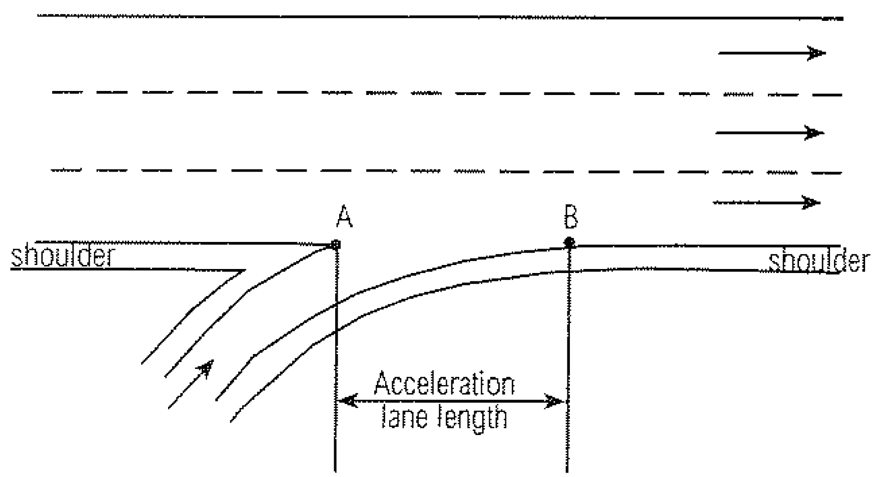
Intersections

In this section are presented the results of the analysis of existing 2006 intersection levels of service for both the AM and PM peak periods. The

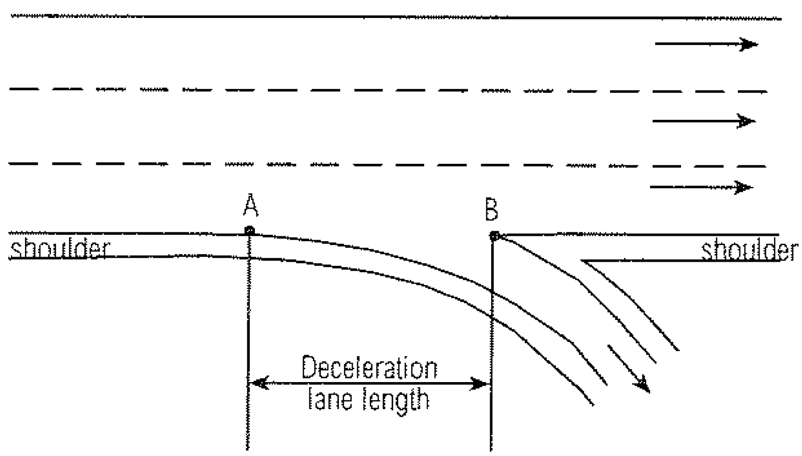
Example of a Weave



Example of a Merge



Example of a Diverge



*Source: Highway Capacity Manual 2000

Figures 2-10
Example of Weave, Merge, and Diverge Operations*

intersections discussed here and shown on the accompanying graphics are those at each interchange along I-495 where on- and off-ramps meet the local street network.

AM Peak Hour

Figures 2-11 and 2-12 graphically illustrate existing 2006 AM peak hour levels of service for signalized and unsignalized intersections in the Western and Eastern Segments of the study corridor, respectively.

As can be seen from Figure 2-11, the Western Segment of the study corridor contains six interchanges with local streets. These interchanges are Exits 32 through 34 and Exits 37 through 39. These 6 interchanges, in turn, consist of 12 intersections that were the subject of the analyses. A total of 6 of the 12 intersections are signalized while 6 are unsignalized. The signalized intersections are located at Exits 32, 38, and 39.

Figure 2-11 shows that all (100 percent) of the six signalized intersections in the Western Segment currently operate with overall LOS A through LOS D conditions. There are a total of 44 movements within these 6 signalized intersections that were analyzed, with 42 of them (95 percent) determined to be currently operating at LOS D or better. The two exceptions are a left-turn movement at Exit 39 NB in Tewksbury and a through movement at Exit 39 SB in Tewksbury. LOS E conditions currently apply to these two movements within these two signalized intersections.

Unsignalized intersections do not receive an overall determination of their level of service, as do signalized intersections. Rather, level of service is determined only for conflicting movements. Of the total of 23 movements analyzed at the 6 unsignalized intersections in the Western Segment of the study corridor, 20 of them (87 percent) were determined to be currently operating in the LOS A through LOS D range. The three movements (13 percent) that were not determined to be within this range are at Exit 33 NB in Chelmsford, Exit 37 NB in Lowell, and Exit 37 SB in Lowell. In each case, the movements involved were determined to be currently operating at LOS F.

Turning now to the Eastern Segment of the study corridor, Figure 2-12 shows that five signalized intersections were analyzed. All five of these signalized intersections were determined to be operating at LOS D or better overall. These 5 intersections have a total of 34 movements that were analyzed for existing level of service. All movements (100 percent) were also determined in the analyses to be operating at LOS D or better.

A total of 15 unsignalized intersections were also examined in the Eastern Segment. These unsignalized intersections contain a total of 63 movements. Of these, 59 movements (94 percent) were determined to be currently operating at LOS D or better. The remaining four movements (six percent) operate under LOS F conditions. These latter movements occur at Exit 43 NB in North Andover, Exit 43 SB in North Andover, Exit 50 SB in Haverhill, and Exit 55 NB in Amesbury.

PM Peak Hour

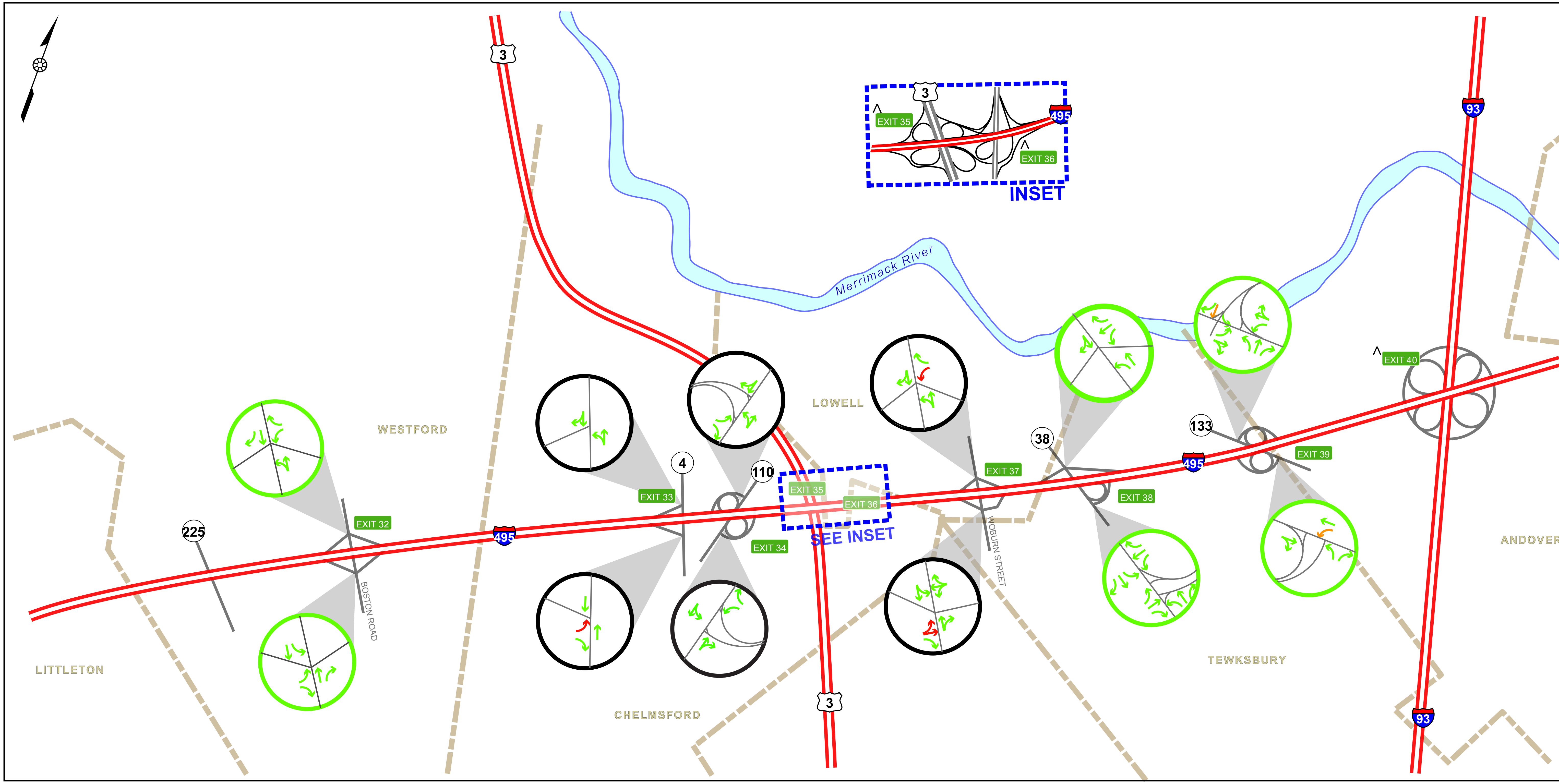
Existing 2006 levels of service determinations for signalized and unsignalized intersections in the Western and Eastern Segments of the study corridor during the PM peak hour of analysis are graphically presented in Figures 2-13 and 2-14, respectively.

Looking first at the Western Segment of the corridor, Figure 2-13 shows that all six signalized intersections currently have an overall level of service in the LOS A through LOS D range. Again, however, there are several individual movements within these intersections whose levels of service do not fall within this range. Specifically, of the total of 44 movements at signalized intersections that were analyzed, there are 3 movements (7 percent) with LOS E conditions and 2 movements (5 percent) with LOS F conditions. The three movements with LOS E conditions are all located at Exit 38 NB in Tewksbury while the two movements with LOS F conditions are found at Exit 39 SB, also in Tewksbury.

With regard to unsignalized intersections in the Western Segment of the I-495 corridor, Figure 2-13 shows that 18 movements (78 percent) of the 23 movements that were analyzed currently operate in the LOS A through LOS D range. The remaining 5 movements (22 percent) currently operate with LOS F conditions. These latter movements are located at Exit 33 NB in Chelmsford, Exit 34 NB in Chelmsford, Exit 34 SB in Chelmsford, Exit 37 NB in Lowell, and Exit 37 SB in Lowell.

In the Eastern Segment during the PM peak hour, as shown on Figure 2-14, the 5 signalized intersections analyzed have 33 movements (97 percent) out of the total of 34 movements currently operating at LOS D or better. The one remaining movement (3 percent) operates at LOS E and is located at Exit 46 NB in Methuen.

The 15 unsignalized intersections contain a total of 63 movements that were analyzed. It was determined that 54 movements (86 percent) operate currently at LOS D or better. Of the remaining nine movements (14 percent), three movements (5 percent) operate at LOS E. These three



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

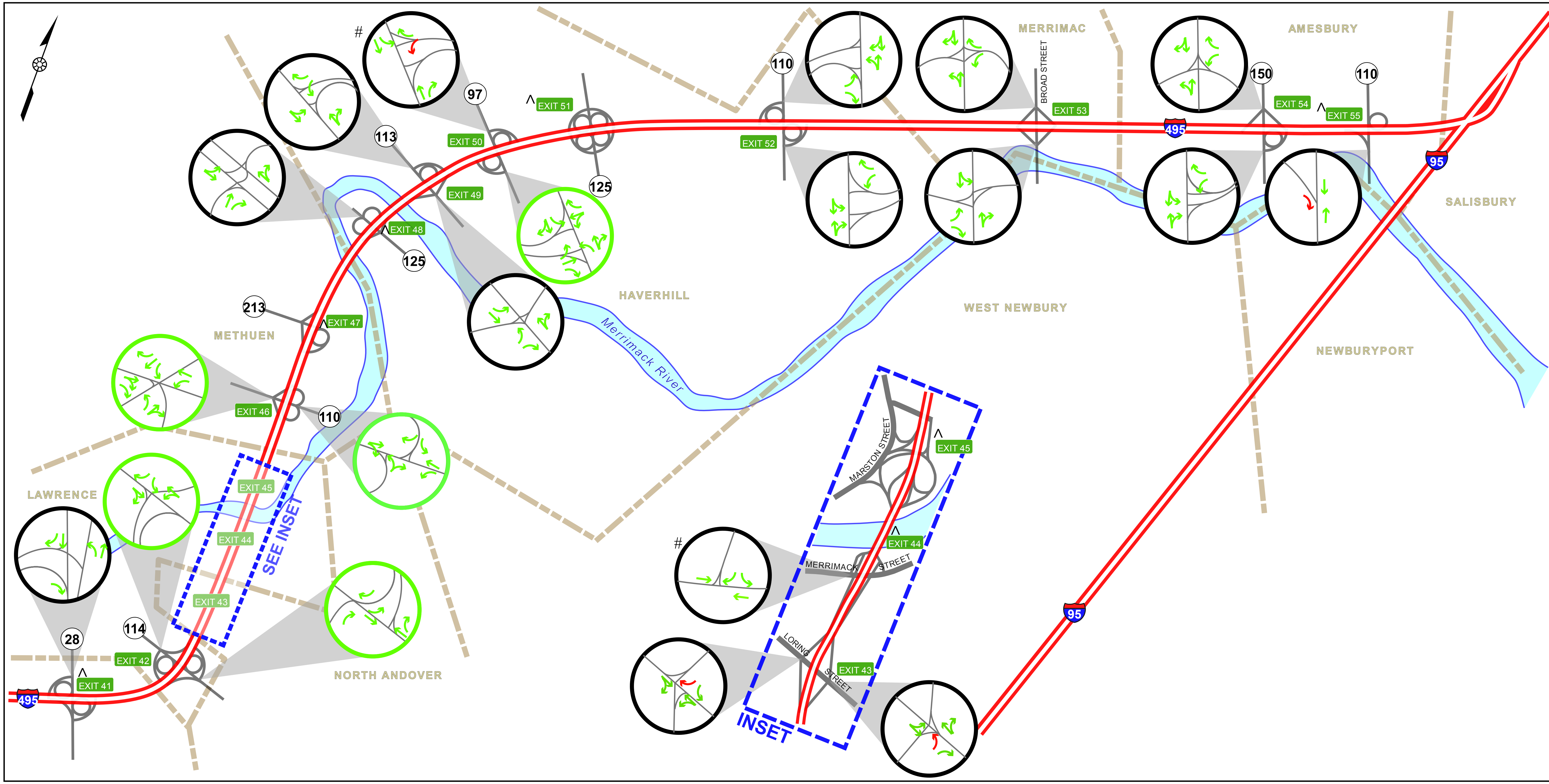
LOS E

LOS F

^ Refer to Figure 2-15 for ramp operations

Figure 2-11*
2006 AM Peak Hour LOS Intersection Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



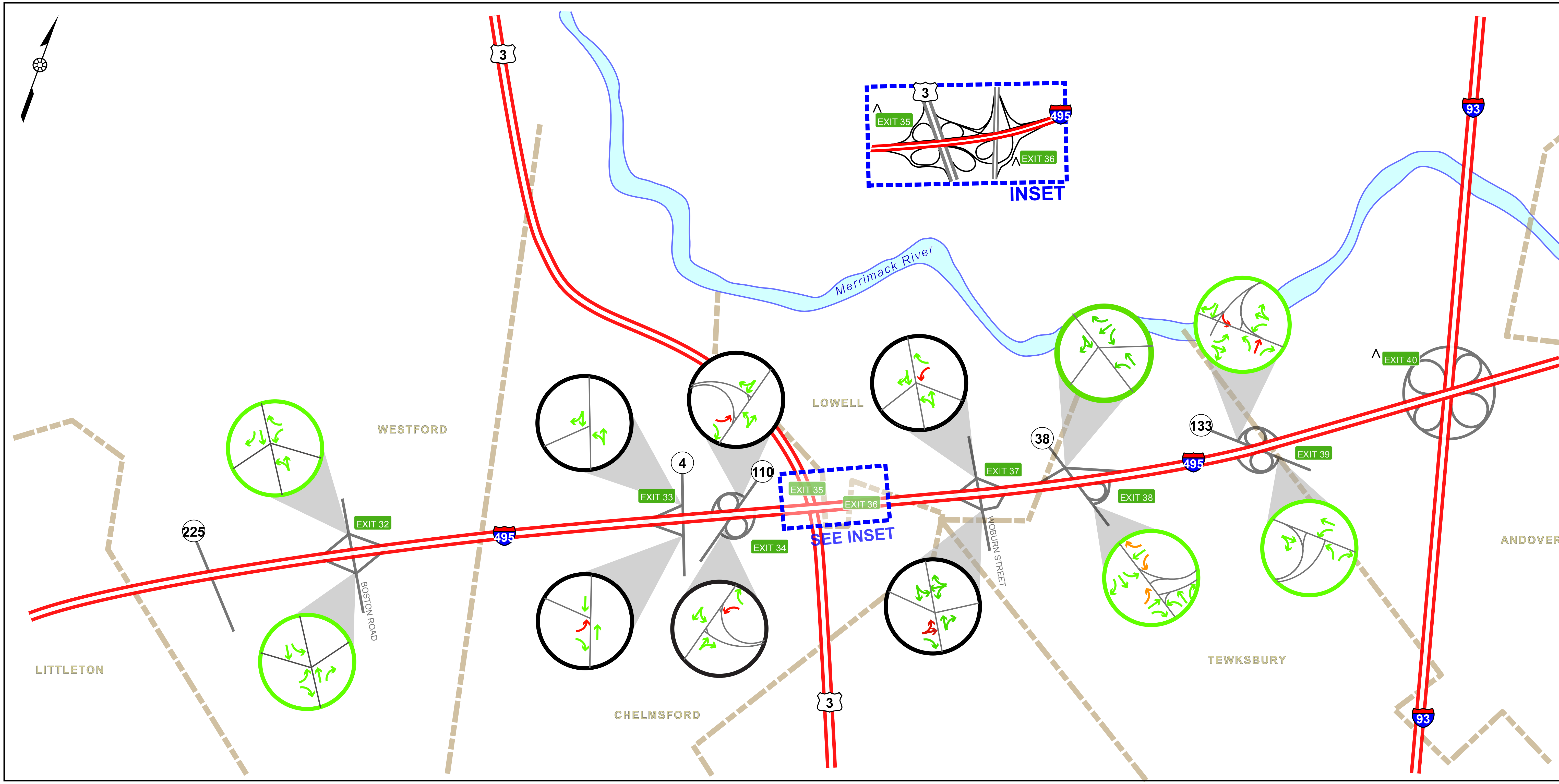
Legend

- Signalized Intersection - Overall intersection LOS shown by color of circle
- Unsignalized Intersection - Overall intersection LOS not applicable
- LOS A - D
- LOS E
- LOS F

^ LOS was only calculated for intersections with stop and signal control
# Intersection was signalized after data was collected for existing conditions. It is analyzed as a signalized intersection in the future 2030 case.

Figure 2-12*
2006 AM Peak Hour LOS Intersection Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

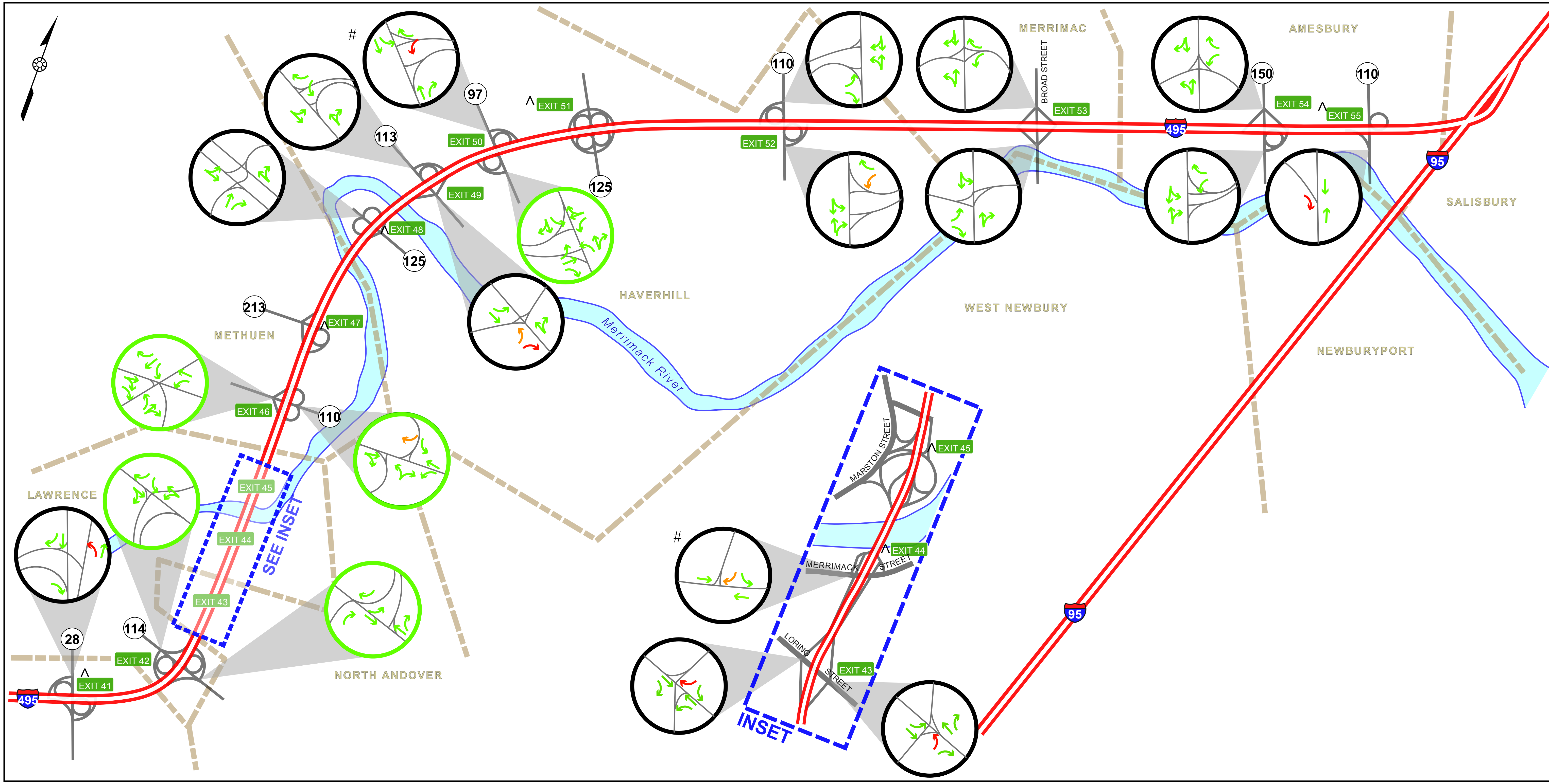
LOS E

LOS F

^ Refer to Figure 2-17 for ramp operations

Figure 2-13*
2006 PM Peak Hour LOS Intersection Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

LOS E

LOS F

^ LOS was only calculated for intersections with stop and signal control

Intersection was signalized after data was collected for existing conditions. It is analyzed as a signalized intersection in the future 2030 case.

Figure 2-14*
2006 PM Peak Hour LOS Intersection Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

movements are located at Exit 44 SB in Lawrence, at Exit 49 NB in Haverhill, and at Exit 52 NB in Haverhill. The remaining six movements (nine percent) operate at LOS F. They are, in turn, located at Exit 41 SB in Andover, Exit 43 NB in North Andover, Exit 43 SB in North Andover, Exit 49 NB in Haverhill, Exit 50 SB in Haverhill, and Exit 55 NB in Amesbury.

Merges, Diverges, and Weaves

In this section are presented the results of analyses performed to determine existing 2006 levels of service with regard to merge, diverge, and weave movements along the I-495 study corridor.

Before discussing the results of this analysis, a brief discussion of acceleration and deceleration lanes is in order. Acceleration lanes are features on a highway that allow a vehicle entering the highway from an on-ramp to merge into the through traffic. A deceleration lane serves the opposite purpose. That is, it is a feature on the highway that serves as a transition between the right-hand travel lane and an off-ramp. Acceleration and deceleration lanes are demarcated by paint striping. There are required lengths for acceleration and deceleration lanes that are largely based on design speed and roadway grade.

During the course of this study, the lengths of existing acceleration and deceleration lanes on I-495 were compared with required lengths. It was found that many of them are deficient with regard to their lengths. Table B-8 in Appendix B presents detailed information on those acceleration and deceleration lanes that were found to deficient. It must be noted, however, that a deficiency in length does not affect the level of service results described below for merges and diverges. Rather, such deficiencies are better regarded as safety issues. They do influence a driver’s comfort level.

<u>AM Peak Hour</u>

Figures 2-15 and 2-16 give a visual presentation of the analysis results for the Western and Eastern Segments, respectively, of the study corridor for the existing 2006 AM peak hour. Analysis results for both directions of I-495 are shown on these two Figures.

As Figure 2-15 illustrates, the analyses of the total of 38 existing merge, diverge, or weave movements studied in the Western Segment of the corridor indicated that 34 locations (89 percent) are operating in the desirable LOS A through LOS D range during the AM peak hour. However, one movement (three percent), a weave on the northbound side of I-495 in Chelmsford, is operating at LOS E and three movements (eight

percent), consisting of one weave at Exit 40 in Andover and two diverges, one on the northbound side of I-495 at Exit 37 in Lowell and the other on the southbound side of the highway at Exit 34 in Chelmsford, are currently operating with LOS F conditions.

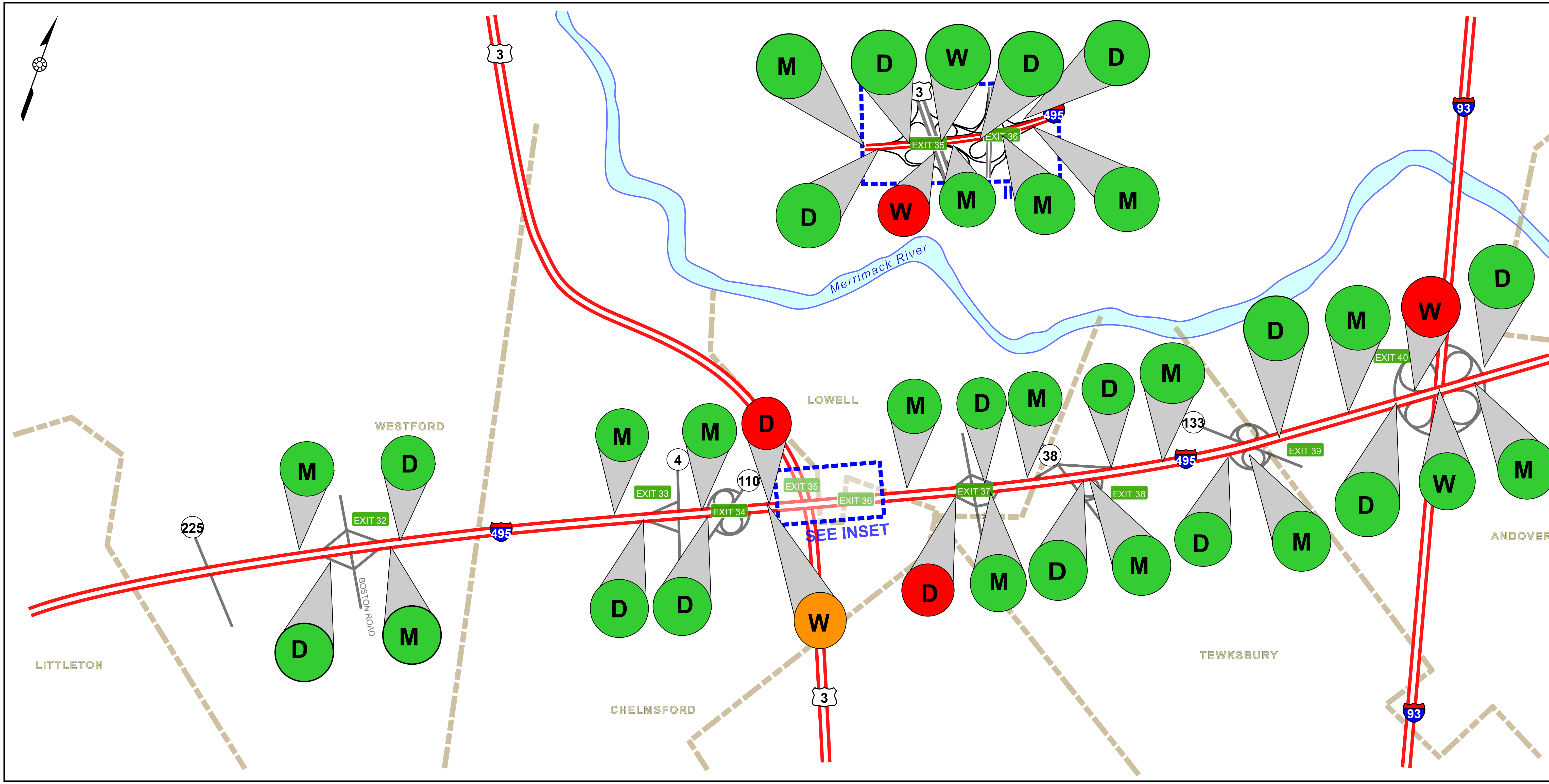
The results of the merge, diverge, and weave analysis for the AM peak hour in the Eastern Segment of the I-495 study corridor are shown on Figure 2-16. A total of 65 merge, diverge, or weave movements was examined. Of this total, it was determined that 61 movements (94 percent) are operating at LOS D or better, 1 diverge movement (2 percent) at Exit 45 in Lawrence is operating at LOS E, and 3 movements (4 percent) consisting of 1 weave movement in Methuen as well as 2 diverge movements at Exits 46 and 47 in Methuen, are currently operating at LOS F.

Of note with regard to the Eastern Segment is the observation that all the merge, diverge, or weave movements that are currently operating at LOS E or LOS F are on the westbound side of the I-495 highway. This fact reflects the predominance of traffic flow in that direction in the Eastern Segment during the AM peak hour.

PM Peak Hour

The results of the analyses performed with regard to merge, diverge, and weave movements for the existing 2006 PM peak hour are summarized graphically on Figures 2-17 and 2-18 for Western and Eastern Segments, respectively, of the I-495 study corridor.

Looking first at the Western Segment, as illustrated on Figure 2-17, the analyses indicated that, of the 38 merge, diverge, or weave movements examined, 32 movements (84 percent) are operating at LOS D or better. The remaining six locations (16 percent) are operating at either LOS E or LOS F levels. Specifically, two movements (five percent) consisting of a weave movement at Exit 35 in Lowell and a weave movement at Exit 40 in Andover are operating at LOS E. The remaining 4 movements (11 percent), consisting of 2 weaves and 2 diverges, are operating at LOS F. The weave movements are at Exit 34 in Chelmsford and at Exit 35 in Lowell. The diverge movements in question are at Exit 34 in Chelmsford and at Exit 37 in Lowell. Of the total of six movements operating at either LOS E or LOS F, there are three in each direction of I-495.

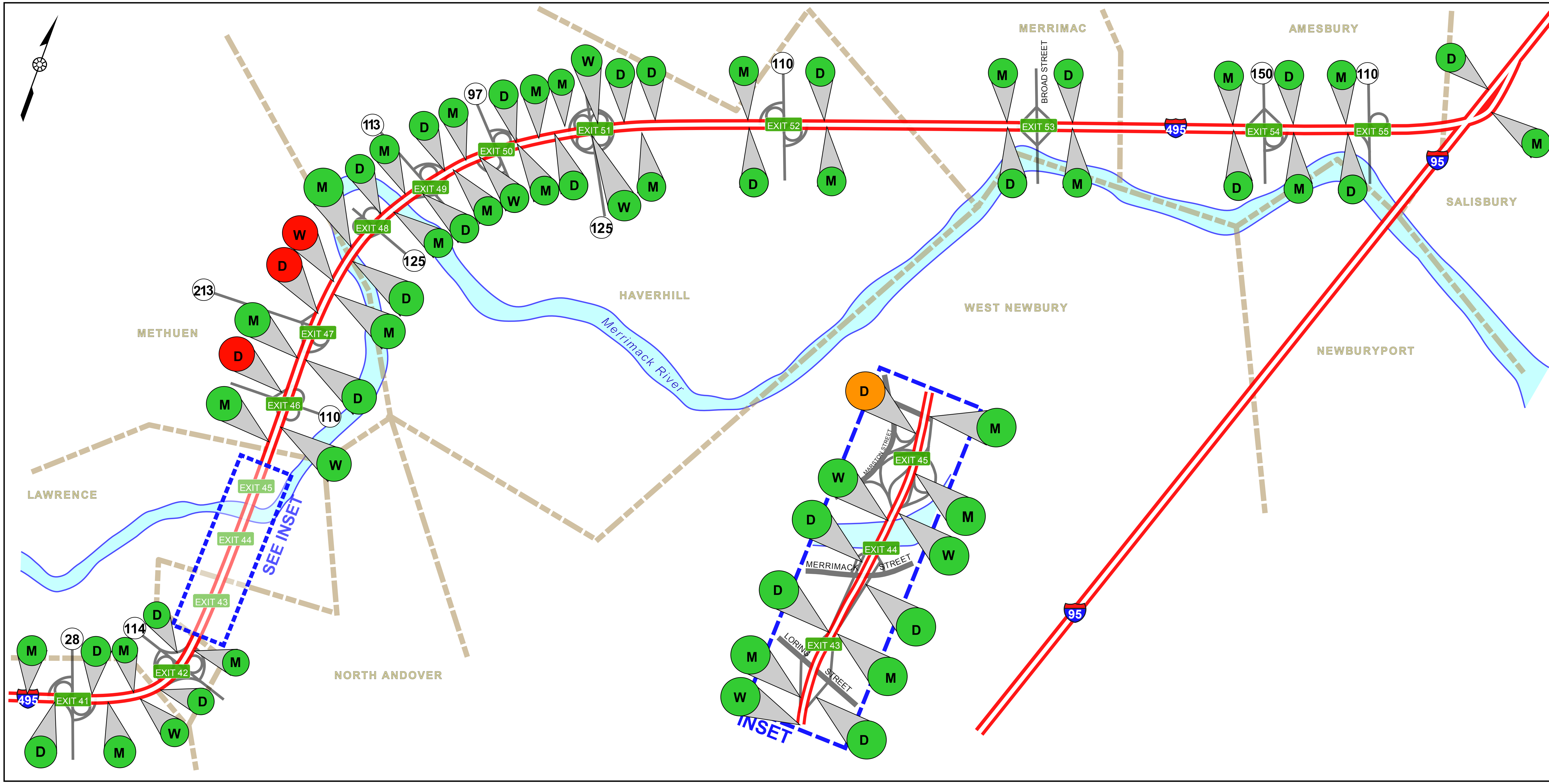


Legend

(green)	LOS A - D	**D**	Diverge
(orange)	LOS E	**M**	Merge
(red)	LOS F	**W**	Weave

Figure 2-15*
2006 AM Peak Hour Ramp Operations
Western Segment

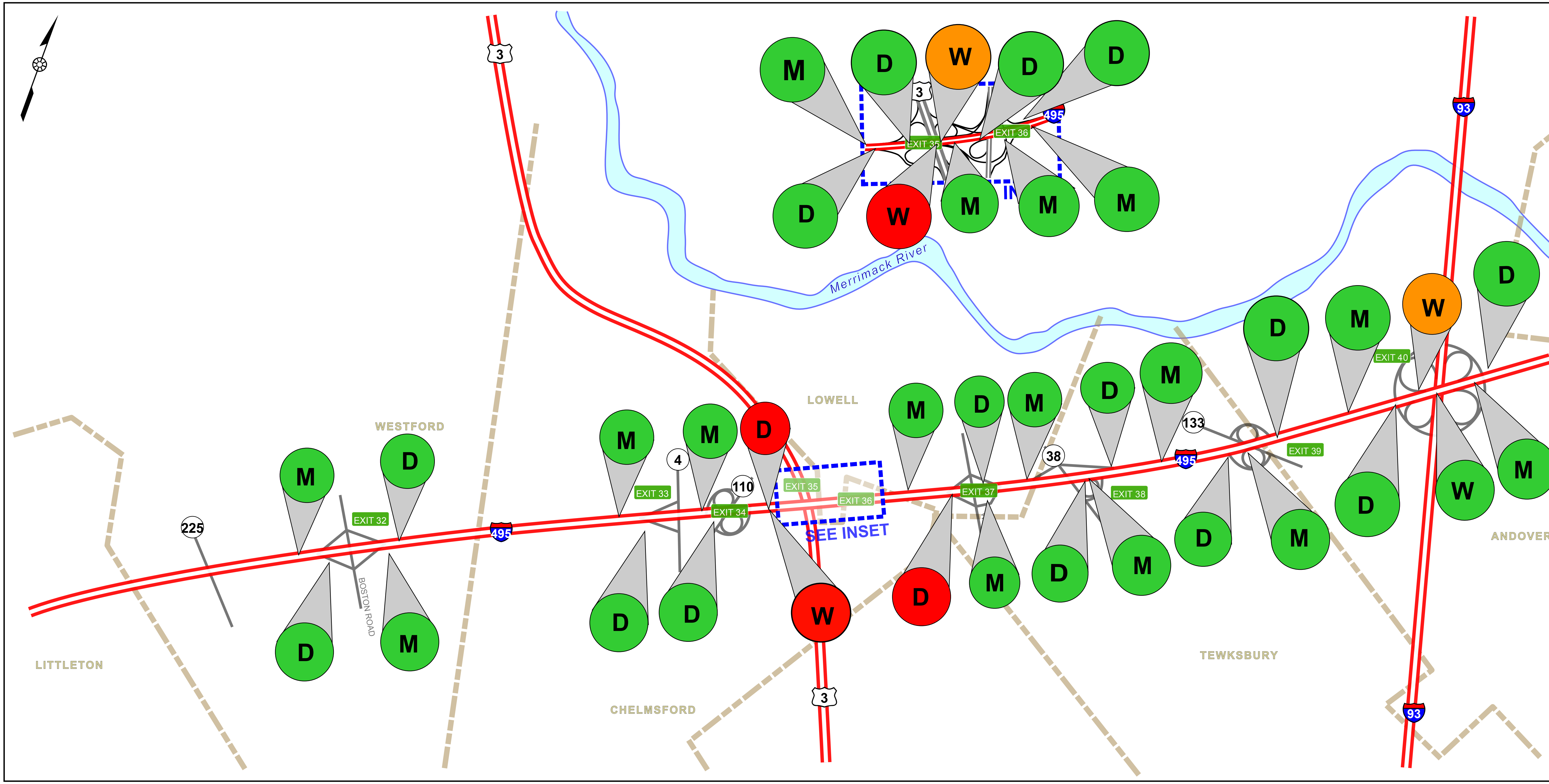
*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Figure 2-16*
2006 AM Peak Hour Ramp Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

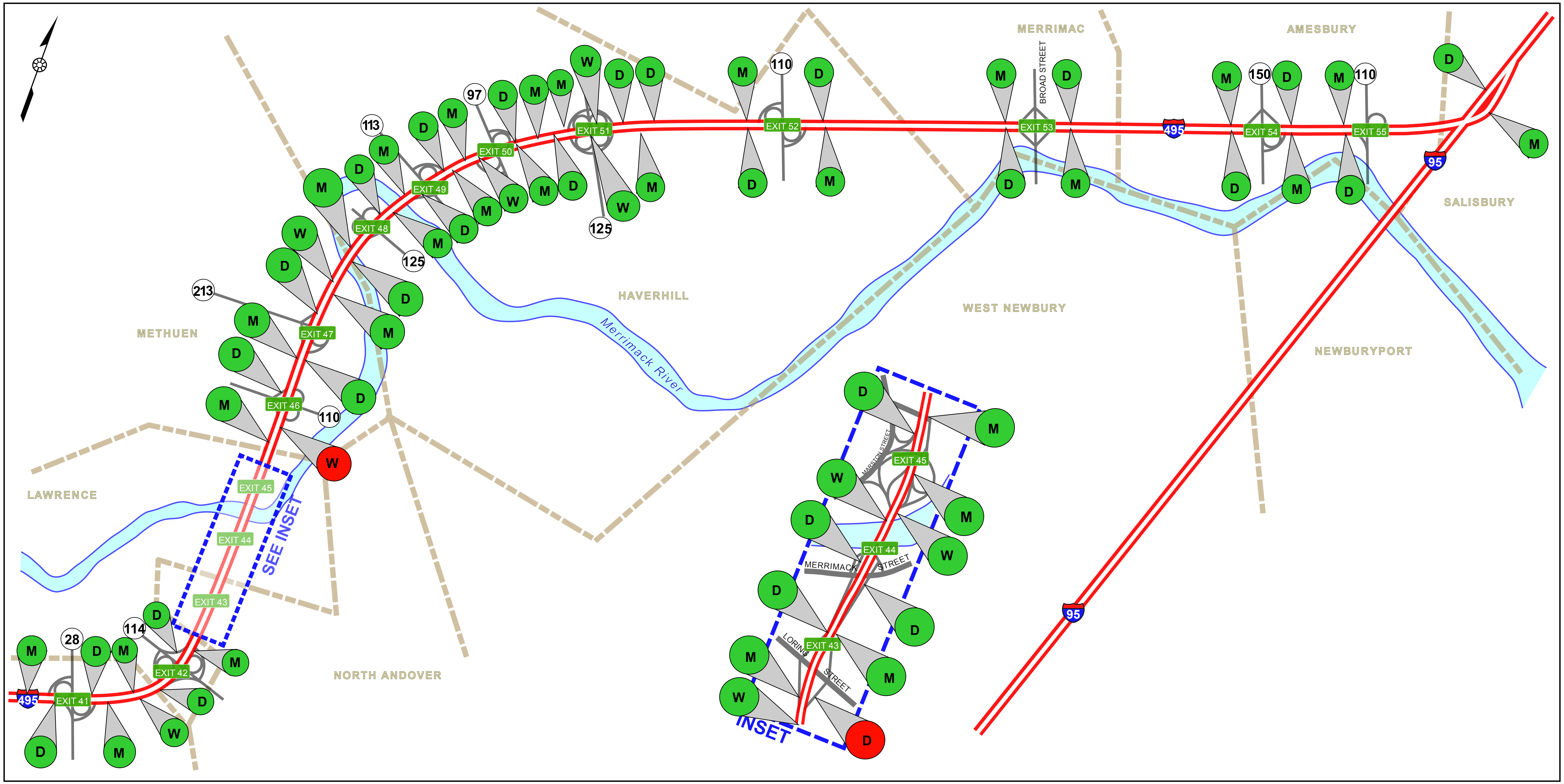


Legend

(green)	LOS A - D	D	Diverge
(orange)	LOS E	M	Merge
(red)	LOS F	W	Weave

Figure 2-17*
2006 PM Peak Hour Ramp Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

- LOS A - D
- LOS E
- LOS F
- **D** Diverge
- **M** Merge
- **W** Weave

Figure 2-18*
2006 PM Peak Hour Ramp Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

Existing conditions in the Eastern Segment of the study corridor with regard to merges, diverges, and weaves are illustrated on Figure 2-18. As can be seen, 63 movements (97 percent) of the total of 65 movements analyzed are currently operating in the LOS A through LOS D range, with the remaining 2 movements (3 percent) experiencing LOS F conditions. These two movements with LOS F conditions are a diverge movement at Exit 43 in North Andover and a weave movement at Exit 46 in Methuen. No merge, diverge, or weave movements in the Eastern Segment were determined to be operating at LOS E during the PM peak hour.

Of the two locations that currently are experiencing LOS F conditions, both are located in the eastbound direction of the highway, reflecting the predominant flow of traffic in that direction in the Eastern Segment during the PM peak hour.

Links

Finally, with regard to LOS on I-495's links, six links in each direction were selected for analysis. The selected links were those in a given area and cross-section with the highest traffic volumes. All of these selected links were determined to be operating at LOS D or better during both the AM and PM peak hours, as shown in Table 2-4. Since these were the links with the highest volumes, it can be stated that the remaining, non-analyzed links, also are operating at LOS D or better.

Table 2-4
I-495 AM and PM Peak Hour Level of Service for Selected Link Analysis

Dir.	Link		Location	AM Volume	Density (pc/mi/ln)[1]	LOS	Volume	Density (pc/mi/ln)[1]	LOS
NB	**36**	**37**	**Chelmsford-Lowell**	5,600	33	D	5,300	30	D
NB	**39**	**40**	**Tewksbury-Andover**	4,400	24	C	5,150	29	D
NB	**45**	**46**	**Lawrence-Methuen**	3,000	16	B	5,500	32	D
NB	**47**	**48**	**Methuen-Haverhill**	3,400	18	C	5,650	33	D
NB	**54**	**55**	**Amesbury**	2,000	11	A	2,400	13	B
SB	**55**	**54**	**Amesbury**	2,250	12	B	2,150	11	B
SB	**49**	**48**	**Haverhill**	5,550	33	D	3,400	18	B
SB	**47**	**46**	**Methuen**	5,000	28	D	3,250	17	B
SB	**41**	**40**	**Andover**	4,750	26	D	3,600	19	C
SB	**38**	**37**	**Tewksbury-Lowell**	5,450	32	D	5,500	32	D
SB	**35**	**34**	**Chelmsford**	4,950	28	D	5,450	31	D

[1]Density is expressed as passenger car per mile per lane.

2.3.1.6 Crashes

Crashes on I-495 were reviewed for the four most recent years (2002 to 2005) available from the Massachusetts Highway Department at the time the data was compiled and analyzed. Figure 2-19 summarizes data for the years 2002 to 2005 for the segments of the I-495 corridor between Westford and Salisbury, organized annually by interchange. (For detailed crash data tables organized by interchange, please see the spreadsheets in the Technical Appendices, separately bound.)

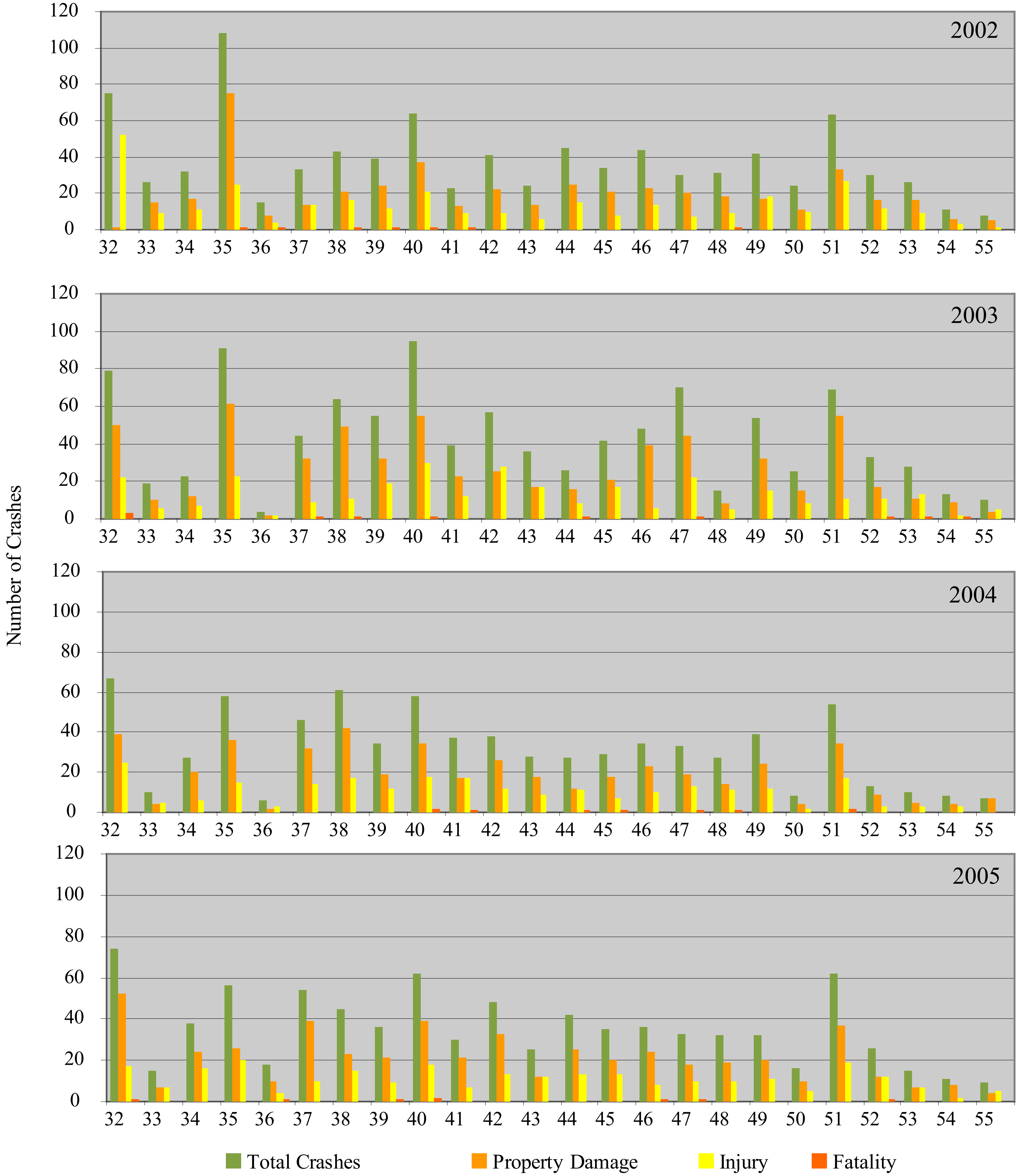
From 2002 to 2005, the total number of reported crashes along the corridor decreased. The severity of crashes from year to year remained proportionally similar, with the majority of crashes reported as property damage only and a very small percentage of fatality accidents. In general, crash volumes are higher in the western segment of the corridor than in the eastern segment. For each year, Exits 32, 35, 40 and 51 have consistently higher crash rates. This data consistently correlates with the higher traffic volumes and lower LOS for these locations.

Table 2-5 presents a summary ranking from 1 to 10 of I-495 study corridor interchanges according to several crash statistics. These statistics include total number of crashes, number of crashes involving property damage, number of crashes involving injuries, and number of crashes involving fatalities.

Table 2-5
Ranking of Corridor Interchanges by Crash Number and Types
2002-2005

Rank	Total Crashes	Property Damage	Injury	Fatality
1	Int. 35	Int. 35	Int. 32	Int. 40
2	Int. 32	Int. 40	Int. 40	Int. 32
3	Int. 40	Int. 51	Int. 35	Int. 47
4	Int. 51	Int. 32	Int. 51	Int. 52
5	Int. 38	Int. 38	Int. 42	Int. 51
6	Int. 42	Int. 37	Int. 38	Int. 48
7	Int. 37	Int. 46	Int. 49	Int. 44
8	Int. 49	Int. 42	Int. 47	Int. 41
9	Int. 47	Int. 47	Int. 39	Int. 39
10	Int. 39	Int. 39	Int.37	Int. 38

Figure 2-19: Annual Crash Statistics by Interchange (2002-2005)



As can be seen from Table 2-5, the interchange that ranks as Number 1 with regard to the total number of crashes occurring during the four-year analysis period was Exit 35. This same interchange also ranks as Number 1 with regard to property damage. Exit 32 was the location of the Number 1 interchange with regard to crashes with personal injuries, while the Number 1 interchange with regard to crashes with fatalities was Exit 40.

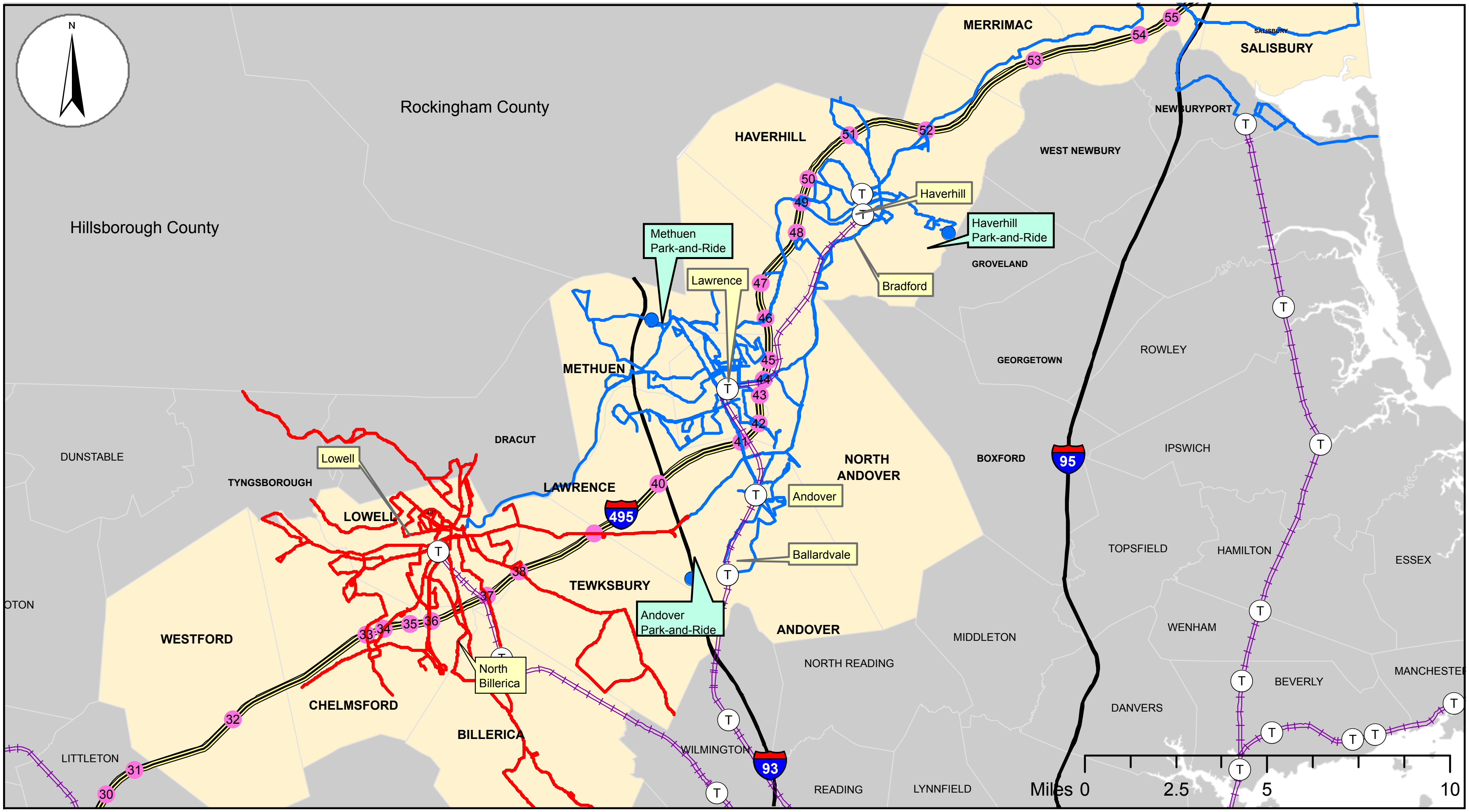
No attempt was made as part of this study to determine crash rates for the locations along the I-495 study corridor, one key reason being the lack of precision regarding the location of crashes in the data available from the Registry of Motor Vehicles. MassHighway is working to geocode crash data in a better manner so that more precision will be available in the future.

As a final comment on crashes, a series of lane departure crashes has been noted, particularly on the section of I-495 to the east of Boston Road in the Westford/Chelmsford area. Lane departure crashes refer to those single-vehicle crashes in which vehicles leave the traveled way, veering off the side of the paved roadway. Such crashes have been investigated by MassHighway for this particular area, but no common thread could be found to link them to any specific problem with roadway design or to traffic conditions.

2.3.1.7 Public Transportation

This section summarizes existing local and commuter transit services and additional services such as employer shuttle routes and paratransit that serve the I-495 corridor between the areas of Lowell to the south and Haverhill to the north. The existing transit services within the study area along the I-495 corridor are provided by three regional transit authorities: the Lowell Regional Transit Authority (LRTA), the Merrimack Valley Regional Transit Authority (MVRTA), and the Massachusetts Bay Transportation Authority (MBTA), and two transportation management associations (TMAs), the Junction TMO and the Merrimack Valley TMA. It should be noted that the information contained in this section (i.e., routes, schedules, operating hours, fares, etc.) was accurate at the time of its writing but is subject to occasional changes, most of which tend to be relatively minor in nature.

As shown in Figure 2-20, transit within the corridor generally radiates from each transit operator’s hub into the surrounding localities with few inter-transit agency connections. These routes are discussed below within the context of each transit authority.



Source: MassGIS, CTPS, Lowell Regional Transit Authority, and Merrimack Valley Regional Transit Authority, 2004 and 2005

Legend

MVRTA Bus Routes	Commuter Rail
LRTA Bus Routes	I-495 Exits
Park and Ride Lots	I-495
Commuter Stations	Major Highways

Figure 2-20
Bus Routes
I-495 Corridor Transportation Study Area

Lowell Regional Transit Authority (LRTA)

The LRTA serves as the central transit service provider for the City of Lowell and the surrounding towns of Chelmsford, Dracut, Westford, Billerica, and Tewksbury. Services offered include fixed-route local bus, commuter bus, a downtown shuttle, and demand response paratransit services for elderly and disabled persons.

In total, the LRTA consists of 18 bus routes, all of which emanate from the Robert B. Kennedy Bus Transfer Center at the Gallagher Intermodal Transportation Center in Lowell as listed in Table 2-6. Services are provided Monday through Saturday on most routes, with no service on Sunday.

Table 2-6
LRTA Bus Routes and Operational Characteristics

Route		Terminus/Town	Start Time	End Time	# Daily Trips	Peak Headway	Off Peak Headway	Saturday Service
1	Christian Hill	Village Square, Dracut	6:00 AM	7:15 PM	28	60	60	Yes
2	Belvidere	Lowell	6:15 AM	7:20 PM	56	30	30	Yes
3	South Lowell	North Billerica Station, Billerica	5:55 AM	6:35 PM	34	30	60	Yes
4	Shaw-Stevens Streets	V.A. Clinic, Lowell	5:55 AM	6:30 PM	42	25	60	Yes
5	Westford St/ Drum Hill	Drum Hill, Chelmsford	6:00 AM	7:00 PM	56	30	30	Yes
6	Broadway/ UMASS Lowell	UMass North & South, Lowell	6:05 AM	6:00 PM	42	35	35	Yes
7	Pawtucketville	Lowell Regional Voke Tech, Lowell	5:55 AM	7:35 PM	57	30	30	Yes
8	Centralville	Hannaford, Dracut	6:10 AM	6:35 PM	32	30	60	Yes
9	Downtown Circulator	Lowell	6:10 AM	10:55 PM	25	30	30	Yes
10	Dracut/ Tyngsboro	Ayotte’s, Hudson, NH	6:35 AM	6:20 PM	24	60	60	Yes
11	IRS/Raytheon	Internal Revenue Service, Andover	6:00 AM	5:25 PM	15	60	60	No
12	Tewksbury	Silver Lake, Wilmington	6:45 AM	5:10 PM	22	60	60	No
13	Billerica/ Burlington via Edson	Lowell/Billerica Line	6:10 AM	6:10 PM	29	30	60	Yes
14	Burlington Mall	Lahey Clinic, Burlington	5:45 AM	6:35 PM	30	55	55	Yes
15	Chelmsford Via Route 129 & 110	Kidder Road Industrial Park, Chelmsford	6:15 AM	6:35 PM	21	60	60	No
16	Chelmsford Center and Drum Hill	Drum Hill, Chelmsford – Starts and ends at Lowell/Chelmsford line	6:15 AM	7:25 PM	28	25	70	Yes
17	North Chelmsford via Middlesex Street	North Chelmsford	6:00 AM	6:35 PM	30	30	60	Yes
18	Express Shuttle	Lowell	5:30 AM	7:00 PM	55	30	30	Yes

While the LRTA does not have special shuttle bus services to employment centers other than downtown Lowell, service from Gallagher Intermodal Transportation Center to the Internal Revenue Service and Raytheon complexes in Andover is provided via Bus Route #11.

The demand response paratransit services for elderly and disabled persons, known as Road Runner, operate from 8:00 AM to 4:00 PM. Monday to Friday and require two business days advance notice. Fares are $1.00 for travel in Lowell, and $1.50 for travel to the surrounding communities in the LRTA area. In addition, the Road Runner service makes one weekly trip to Boston every Wednesday, at a cost of $25.00 per round trip.

Ridership on LRTA bus routes has remained constant from 1998 to 2005, with occasional peaks and drops. Ridership was up in the fall of 2007 and continued to climb throughout the year. It is expected to be up by three to five percent for spring 2008 counts.[1] Fares for fixed-route service are also $1.00 for travel in Lowell, and $1.50 for travel to the surrounding communities in the LRTA area. LRTA routes ranked based on fall 2007 ridership levels are shown in Table 2-7. The Downtown Transit Center on Paige Street was relocated to the Kennedy Bus Transfer Center at the Gallagher Terminal in September 2005.

Routes to employment centers such as the Internal Revenue Service and Raytheon along State Route 133 in Andover (LRTA Bus Route #11) ranked low, averaging only 64 riders per day.

Table 2-7
Top 2007 LRTA Bus Routes Based on Daily Ridership

LRTA Bus Route		Fall 2007	Percent of Ridership
18	Express Shuttle	882	14.38
7	Pawtucketville	839	13.68
5	Westford Street	708	11.54
2	Belvidere	505	8.23
14	Burlington/Lahey	393	6.41
4	Shaw-Stevens	366	5.97
13	Billerica/Edson	265	4.32
17	North Chelmsford	262	4.27
16	Chelmsford/Chelms Street	260	4.24
3	South Lowell	260	4.24
8	Centerville	229	3.73
10	Dracut/Tyngsborough	215	3.52
9	Downtown Circulator	215	3.51
12	Tewksbury/Route 138	211	3.44
6	Broadway/UMASS	176	2.87
1	Christian Hill	171	2.79
15	Chelmsford/Route 129	112	1.83
11	IRS/Route 133	64	1.04

Source: Lowell Regional Transit Authority

[1] NMCOG, May 2008.

Merrimack Valley Regional Transit Authority (MVRTA)

The MVRTA serves as the primary transit agency for the Merrimack Valley communities of Andover, North Andover, Lawrence, Methuen, Haverhill, Merrimac, Amesbury, Newburyport, and Salisbury. Services offered include fixed-route local bus originating either at the Buckley Transportation Center in Lawrence, or at the Washington Square Transit Center in Haverhill. Full fare is $1.00, with reduced fares for pass programs. Other services include advance request transport (Ring & Ride), commuter bus, bus service to major employers called Special Employment Shuttles, and demand response services for elderly and disabled persons. In addition, the MVRTA provides service to the Gallagher Intermodal Transportation Center (Bus Route #41) for onward connections to points served by LRTA and the Lowell commuter line of the MBTA.

The MVRTA fixed-route bus service consists of 24 routes, which includes commuter bus and special employment shuttles. Services are provided Monday through Saturday on most routes with no service on Sunday. Hours of operation for each route are shown in Table 2-8, which also shows the number of daily trips provided.

The MVRTA operates one commuter bus route through the communities of Andover, Lawrence, and Methuen into downtown Boston via I-93. This service operates Monday through Friday and only in the peak direction. Three trips run inbound into Boston in the morning, with the first run at 5:45 AM and the last at 6:45 AM.[1] In the evening, three trips run outbound from Boston with the first run at 4:40 PM and the last at 6:00 PM. Fares are $5.00 one-way with a 10-ride commuter pass option available at a cost of $40.

Two special employment shuttle services (Routes #72 and #73) are also operated by the MVRTA. Route #72 connects downtown Haverhill to the Ward Hill Industrial Park in Haverhill, the Lucent facility in North Andover, and Raytheon and IRS facilities in Andover. Route #73 connects downtown Lawrence to the Lucent facility in North Andover, and to the Raytheon and the IRS facilities in Andover. Route #72 runs one trip in the peak direction in the morning and evening and Route #73 runs two. Ridership on these routes has steadily declined, with Route #72 dropping from 15,406 annual riders in 2001 to 3,417 in 2003. Route #73 has dropped from 14,330 annual riders in 2001 to 2,968 in 2003. The decline in ridership could be related to a drop in employment at these two specific destinations. In 2001, MVRTA discontinued operation of two other Special Employment Service routes: Routes #76A and #76B, to River Road in Andover.

[1] Reflects schedule effective October 24, 2005.

Table 2-8
MVRTA Routes and Service Characteristics

Route		Origin	Start Time	End Time	# Daily Trips	Peak Headway	Off Peak Headway	Saturday Service
01	Lawrence-Methuen-Haverhill	Lawrence	5:00 AM	7:15 PM	57	25	45	Yes
13	Main St/North Ave	Haverhill	5:10 AM	6:35 PM	26	60	60	Yes
14	Ward Hill/ Bradford	Haverhill	5:50 AM	5:30 PM	26	55	60	Yes
15	Hilldale Ave./ Westgate Plaza	Haverhill	5:30 AM	6:25 PM	26	60	60	Yes
16	Washington St./ Westgate Plaza	Haverhill	5:40 AM	6:50 PM	27	60	60	Yes
18	Riverside	Haverhill	5:25 AM	5:45 PM	23	60	80	Yes
19	Westgate Plaza/ Summer St.	Haverhill	5:40 AM	6:15 PM	24	60	75	Yes
21	Andover Shuttle	Andover	7:00 AM	6:30 PM	24	60	60	No
32	Andover	Lawrence	5:00 AM	7:35 PM	56	25	45	Yes
33	North Andover	Lawrence	5:00 AM	7:35 PM	56	25	45	Yes
34	Prospect Hill	Lawrence	5:00 AM	7:31 PM	56	25	45	Yes
35	Water St.	Lawrence	5:00 AM	7:32 PM	56	25	45	Yes
36	Lawrence St./Holy Family Hospital	Lawrence	5:00 AM	7:33 PM	56	25	45	Yes
37	Beacon St.	Lawrence	5:00 AM	7:30 PM	56	25	45	Yes
38	Hampshire St.	Lawrence	5:00 AM	7:34 PM	56	25	45	Yes
39A	Colonial Heights/ N. Andover Mall	Lawrence	5:00 AM	7:36 PM	56	25	45	Yes
39B	N. Andover Mall/ Phillips St.	Lawrence	5:00 AM	7:35 PM	56	25	45	Yes
40	Methuen Sq.	Lawrence	5:00 AM	7:33 PM	56	25	45	Yes
41	Lawrence -Lowell	Lawrence	4:45 AM	7:15 PM	55	25	45	Yes
51	Haverhill/ Merrimac/ Amesbury/ Newburyport	Haverhill	5:00 AM	6:40 PM	25	60	70	Yes
72	Haverhill	Haverhill	5:50 AM	3:25 PM	2	[1]	[1]	No
73	Lawrence	Lawrence	5:55 AM	4:20 PM	4	[1]	[1]	No
83	Salisbury Beach/ Hampton Beach[2]	Lawrence	8:15 AM	4:20 PM	4	[2]	[2]	Yes

Notes: 1. Special employment bus
2. Special bus operating July through September. The fare is $2.00 to Salisbury Beach and $3.00 to Hampton Beach. Multiple ride passes are also available.

Advance request services known as Ring & Ride also provides curb-to-curb transit service along predetermined routes. MVRTA operates eight Ring & Ride routes that offer bus service to the areas of Boxford, Georgetown, Groveland, Salisbury, and West Newbury. These routes all operate from 5:00 AM to 7:00 PM Monday to Friday and from 9:00 AM to 6:00 PM on Saturday. No service is available on Sunday or holidays.

The demand response services for elderly and disabled persons are known as EZ Trans. Similar to the Ring & Ride service, the advance request service provides curb-to-curb service in accessible vehicles that meet

Americans with Disabilities Act (ADA) requirements and special needs. Two levels of service are offered, ADA and non-ADA, with the difference being ADA pickups and drop offs are within ¾-mile of an existing bus line and pay a lower fare.

Annual ridership on the MVRTA was more than 1,942,275 riders in 2006, steadily rising from 2000. The top MVRTA routes based on 2006 ridership levels are shown in Table 2-9. The top two routes account for more than 26 percent of all riders, and these routes connect Lawrence to the urbanized areas within the Merrimack Valley, which the I-495 corridor parallels.

Table 2-9
Top MVRTA Routes in 2002

MVRTA Route		2002 Annual Riders	Percent of Total
1	Lawrence – Methuen – Haverhill	301,143	15.5%
41	Lawrence – Lowell	217,864	11.2%
39B	North Andover Mall/Phillips Street	176,848	9.1%
37	Beacon Street	143,321	7.4%
51	Haverhill-Amesbury-Newburyport	130,863	6.7%
32	Andover	301,143	15.5%

Source: Merrimack Valley Metropolitan Planning Organization 2007 Regional Transportation Plan. Refer to for additional information.

Massachusetts Bay Transportation Authority (MBTA)

The MBTA is the major transit provider for the Boston metropolitan area. Within the I-495 corridor study area, the MBTA operates two radial commuter rail lines to Boston, the Lowell line and Haverhill/Reading line.

The Lowell line operates from North Station in Boston and serves seven stations in addition to its terminus at the Gallagher Intermodal Transportation Center in Lowell. The commuter train operates seven days a week with reduced service on the weekends. Weekday service consists of 22 inbound trains from Lowell to Boston and 22 outbound trains to Lowell, with trains departing from 5:35 AM to 12:10 AM[1]. Two stations on the Lowell line are located within the study area; Lowell, located in Zone 6 and North Billerica, located in Zone 5. One-way fares from these stations to North Station in Boston are $6.75 and $6.25, respectively, with reduced ticket prices available on monthly passes.

The Lowell line averages about 6,500 inbound boardings per day.[2] Nearly 38 percent of these boardings occur at two stations located within the study

[1] MBTA Commuter Rail Train Schedule, effective October 29, 2007
[2] MBTA FY’08 Average Ridership for the period of July 2007 through April 2008.

area: Lowell and North Billerica stations. On a train audit conducted on February 28, 2008, the Lowell station had 1,398 boardings and North Billerica had 1,043 boardings, out of a total of 6,434 daily boardings for the line. These boarding numbers are consistent with ridership levels seen at the Lowell and North Billerica stations since 2000-2001, which would indicate a constant demand. However, this constant demand may be due at least partially to the unavailability of parking and rolling stock capacity limitations.

The Haverhill/Reading line operates from North Station and serves twelve stations in addition to its terminus station in Haverhill. The commuter train operates seven days a week with reduced service on the weekends. Weekday service consists of 13 inbound trains to Boston and 13 outbound trains from Boston, with trains departing from 5:10 AM to 12:10 AM.[1] Typical travel time between Haverhill and Boston is approximately 1 hour to 1 hour and 10 minutes, depending on the number of station stops. One-way fares from Haverhill are $7.25 (Zone 7), with reduced ticket prices available on monthly passes. This line roughly parallels I-495 in the study area with five stations located in this section: Ballardvale, Andover, Lawrence, Bradford, and Haverhill.

The Haverhill line averages about 5,000 inbound boarding per day.[2] Roughly 46 percent of these boardings occur at the five stations located within the study area. On a train audit conducted on February 28, 2008, daily boardings for each of the five stations were: Haverhill station 583, Bradford station 480, Lawrence station 738, Andover station 553, and Ballardvale station 292, for a total of 2,646 out of 5,727 boardings.

AMTRAK

Amtrak's *Downeaster* train offers five daily roundtrips seven days a week between Boston's North Station and Portland, Maine. This train makes station stops at Haverhill Station. The journey time from Haverhill to Boston is approximately 50 minutes. The one-way fare is $10.00, with discounts available for multi-trip and monthly passes. It is possible to use the *Downeaster* service to commute between Haverhill and Boston. However, the MBTA offers more frequent service at a lower fare, making the *Downeaster* a less attractive option as a commuter service. Nevertheless, some people do use the *Downeaster* to commute to Boston because its travel time is faster (50 minutes versus 69-70 minutes on commuter rail) and it arrives in Boston at a good time (8:25 AM).

[1] MBTA Commuter Rail Train Schedule, effective October 29, 2007
[2]MBTA FY'08 Average Ridership for the period of July 2007 through April 2008.

Intercity Bus

Intercity bus transportation is available within the region in Lowell on Peter Pan Bus Lines and Vermont Transit Lines. Peter Pan Bus Lines has two routes from Lowell, Route #226 and Route #227. Both these routes utilize I-495 and extend south to Washington, DC via Springfield, Massachusetts; but neither have a stop in Boston. Vermont Transit Lines, a subsidiary of Greyhound Lines, offers transportation to Manchester, New Hampshire or Boston. The company operates three daily trips in each direction connecting Manchester and Boston, one of which stops in Lowell at the Gallagher Intermodal Transportation Center. Fares from Lowell and Manchester are between $12.50 and $14.50 for non-refundable tickets, with no commuter discounts available. Additional service connecting Manchester and Boston is operated by Concord Trailways. This commuter service offers fares of $11 one way, $20 round trip, and $65 per month, however, it does not have stops within the I-495 corridor.

2.3.1.8 Transportation Management Associations (TMAs)

TMAs are private non-profit associations created to alleviate the burdens of commuting for one specific employer or a collection of employers in a geographically proximate area. Their mission is to reduce the number of single-occupant vehicles on the roadway system and to promote alternative modes of transportation. Within the Merrimack Valley there are two TMAs, the Junction TMO that handles the I-93 junction area of Andover, Wilmington, and Tewksbury; and the Merrimack Valley TMA that handles the employers in the communities of Andover, North Andover, Lawrence, and Methuen.

Junction TMO

The Junction Transportation Management Organization (TMO) operates the Call & Commute shared van and ride-matching services and serves approximately 110 riders per day, primarily the employees of Wyeth BioPharma in Andover, one of the largest employers in the Merrimack Valley with 1850 personnel. Gillette, which is located adjacent to Wyeth, operates its own in-house ride-matching and commuter service for employees. The service operates only during morning and evening peak hours with reservations required one day in advance.

A daily shuttle van from Wyeth also serves the Ballardvale commuter rail station located in Andover for two morning trips and two evening trips. The majority of users of services provided by the Junction TMO are located in New Hampshire along the I-93 corridor.

All services operated in conjunction with the Junction TMO include the guaranteed ride home emergency services that serve as backup to taxi service, ensuring users with a way home.

Merrimack Valley TMA (MVTMA)

This association, formerly known as the River Road TMA, serves the greater Andover area and offers a comprehensive package of transportation incentives designed to encourage commuters who currently drive alone to work to travel to work together. Participating commuters who choose transit are eligible for Commuter Check vouchers to purchase a monthly pass, up to a maximum of $35 per month for three months. The MVTMA currently operates four vanpools, all of which originate in New Hampshire and serve the I-93 corridor. Although no transit or bus service is provided by MVTMA, ride matching and the Guaranteed Ride Home taxi program are available.

2.3.1.9 Park & Ride Lots

Park & Ride lots offer commuters the ability to carpool or use transit where none may be available. Many of these lots are located near major highways and all day parking is often free of charge. Usage of Park & Rides reduces the number of single-occupant vehicles on the highway and parking demand at the final destination. There are three Park & Ride lots in the study area operated by MassHighway and the MVRTA. With one exception, these lots are located along I-93 and all generally serve commuters traveling to Boston. Park & Ride lots in the study area are listed in Table 2-10.

Table 2-10
Park & Ride Lots in the Study Area

Park & Ride	Location	# Parking Spaces	Available Transit Services
Andover	I-93 exit 42	71	None
Methuen	I-93 exit 47	189	MVRTA – # 40; also service to Boston
Haverhill	Routes 97 & 113	40	MVRTA – # 1, 18, 51; also service to Boston

2.3.1.10 Summary Evaluation of Existing Transit Conditions

Existing transit service within the study area centers on the older industrial cities of the Merrimack Valley: Lowell, Lawrence, and Haverhill, with bus service radiating into adjacent communities. The existing routes primarily serve the population within these cities, and most service ends in the early

evening (6-7 PM). None of the LRTA or MVRTA bus routes operates on I-495. Limited service to major employment centers is offered at peak times, with trips often restricted to one to two trips in the peak periods and often only in the peak direction. Service is offered between the Lowell and Lawrence areas via one route, Bus Route #41, operated by the MVRTA, which ranks as the MVRTA's second most popular bus route based on ridership. In addition, the MVRTA had offered special employment bus routes from Lawrence to employment centers along River Road in Andover, but bus these routes were discontinued in 2001. At that time, annual ridership the routes was 8,748 and 6,329 respectively, for a combined total of 15,077 annual riders.

Commuter rail service provided by the MBTA connects the greater Lowell, Lawrence, and Haverhill areas to Boston.

2.3.1.11 Regional Transit Travel Times

Table 2-11 shows transit travel times for selected points within the study area using existing transit. The points selected are those locations that have available transit service that rated highly in commuting based on ridership levels or 1990 journey-to-work data.

Table 2-11
Regional Transit Travel Times

From	To	Travel Time (min)	Routing
Haverhill	IRS	40	MVRTA 72
Lawrence	Haverhill	40	MVRTA 01
Lawrence	IRS	25	MVRTA 73
Lawrence	Lowell	35	MVRTA 41
Lawrence	IRS	25	LRTA 11
Methuen	Lawrence	17	MVRTA 40
Andover	Lowell	62*	MVRTA 32/ MVRTA 41
North Andover	Lowell	55*	MVRTA 33/ MVRTA 41
Lowell	IRS	25	LRTA 11

* Includes 10 minute transfer time at Buckley Station

2.3.1.12 Trends

It is expected that the current travel patterns and transit usage within the study area will continue, with the providers focused primarily on serving the traditional urban areas of the Merrimack Valley.

According to the 2007 Merrimack Valley Regional Transportation Plan (RTP), the total number of Merrimack Valley residents traveling to work increased 12.4 percent between 1990 and 2000, from 130,672 workers to 146,923 workers. This is slightly greater than the 10.5 percent increase in

the region’s population from 288,280 persons to 318,556 persons over the same period, based on 2000 U.S. Census data. The overall number of Merrimack Valley residents that traveled to work within the Merrimack Valley region dropped by 1.1 percent between 1990 and 2000, while the percentage commuting to all other areas except I-495 increased. Also of note is that the number of Merrimack Valley residents traveling to Central New Hampshire more than doubled (104 percent increase), and that the overall percentage of residents that live and work in the Valley declined from 60.3 percent in 1990 to just under 53 percent in 2000.

The number of jobs in the Merrimack Valley that people traveled to also grew, from 124,015 in 1990 to 138,068 in 2000, an 11.3 percent increase. Census data shows that most of this growth took place in the communities located in the eastern half of the Valley, with additional employment growth taking place in Andover and Haverhill.

With the exception of Southern New Hampshire, there were significant increases in the percentage of persons traveling to work located in Merrimack Valley from all regions, with the I-495 region being most striking at 485.5 percent. In 1990, 61.2 percent of the 133,955 commuters living in the Valley remained in the region for their work. The City of Lawrence was the workplace destination of the greatest number of the region's commuters (over 17,000), followed by Andover and Haverhill. The City of Newburyport had the greatest percentage of intra-town commuters (people who live and work in the same community). By comparison, only 53 percent of the region’s 146,943 commuters remained in the Valley for their work in 2000, a drop of over eight percent. Lawrence continued to be the workplace destination of the greatest number of the region’s commuters (14,357), but with a marked reduction from the 1990 figure.

Over 50,000 residents of the Valley (38.8 percent) commuted outside the region in 1990. That figure grew markedly by 2000 as 69,074 residents commuted outside the region. The largest work community destination for Valley residents in 1990 was Boston. Over 7,000 commuted into Boston (5.2 percent of all commuters). In 2000, 9,124 Valley residents (6.2 percent of all commuters) worked in Boston. Many residents also commute to one of several towns to the south and west in the Route 128 corridor.

The development of additional park and rides at or near interstate or highway interchanges could facilitate and increase the use of transit and carpooling to all destinations. In addition, a connecting service between the two terminal points of the MBTA Lowell and Haverhill commuter rail lines connecting employment centers in Andover and Lowell could increase mobility and access to employment for transit users.

2.3.1.13 Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems (ITS) refers to transportation systems that apply the latest in information technology to mitigate transportation congestion problems. ITS is designed to reduce unnecessary traffic delays by providing the public with the latest information on construction, traffic congestion and accidents via telephone and the Internet. For example, satellite surveillance systems could be used to locate the early stages of congestion on a given route, and traffic then redirected to alternate routes to prevent further aggravation of the problem.

Massachusetts is in the process of developing a regional network of ITS, and has thus grouped the Commonwealth's 13 MPO's into four regions: the Western Massachusetts, the Southeastern Massachusetts, the Central Massachusetts, and the Metropolitan Boston regions. The Metropolitan Boston region covers the area generally within I-495, and thus I-495 serves as a defining boundary for this system.

2.3.1.14 I-495 Rest Areas

A rest area provides a location for drivers to pull off a highway for temporary periods. They are often equipped with toilet facilities.

Four rest areas are currently located along I-495 within the study corridor. In Chelmsford, there are two rest areas just to the west of Westford Road, one on each side of I-495. Further to the east is another rest area located in Haverhill on the eastbound side of I-495 just to the east of State Route 108. The fourth rest area is located in Merrimack near the Haverhill boundary line on the westbound side of I-495.

There are no requirements at the Federal level regarding the need for or spacing of rest areas along an Interstate highway such as I-495.

2.3.2 Land Use

Land use patterns within the study area include the dense urban development of the traditional mill cities of Lowell, Lawrence, and Haverhill that developed along the Merrimack River, and the low-density suburban development as exemplified by Westford and North Andover, that developed in response to the increased accessibility and mobility created by the advent of the Interstate highway. In general, the highway corridor is most densely developed between Exits 33 in Chelmsford and Exit 51 in Haverhill. The eastern end of Haverhill (Exit 52) and the towns of Merrimac, Amesbury and Salisbury (Exits 53 – 55) at the eastern end of the corridor are less densely developed, and are primarily residential in character. (See Figures B-1, B-2, and B-3.)[1]

[1] Please see Appendix B of this document for all figures in this section (Figures B-1 through B-83).

The thirteen study area communities encompass an area of approximately 277 square miles, of which 35.4 percent is residential, 2.4 percent is commercial, and 4.5 percent is in industrial land uses. More than half (56.2 percent) of all industrial land use is in five of the corridor communities: Billerica (15.7 percent), Andover (11.3 percent), Lowell (10.7 percent), Westford (9.7 percent) and Lawrence (8.8 percent). Commercial and industrial uses are either located within the historic city downtowns or along state highways with access to I-495. The U.S. Route 3 and I-93 corridors, in particular contain a large concentration of industrial land uses. Forested land comprises 35.5 percent of the study area, while agricultural and horticultural uses occupy 4.9 percent of the study area.[1] (See Table 2-12.)

An analysis of the full buildout potential of each of the study area communities was conducted by the Massachusetts Executive Office of Environmental Affairs (EOEA). This analysis indicates that there is a potential for more than 34,000 additional residential units and an additional 141 million square feet of commercial and industrial development within the study area, which is based on current (2001) zoning and the amount of developable land available. This analysis does not take into account market demand and the rate of development. The communities with the potential to add the greatest number of housing units are Haverhill (6,838), Lowell (5,495), Westford (4,697), and Andover (3,590). Communities with high potential commercial and industrial growth include: Lowell (23.72 million square feet (msf)), Billerica (18.20 msf), Westford (17.96 msf), Andover (17.71 msf), and Haverhill (17.21 msf). Table 2-13 provides a summary of additional growth potential at full build for the study area communities.

Land use and zoning within one mile of Exits 32 to 55 were analyzed in more detail to identify existing and potential land uses that contribute to travel demand. The following provides a discussion of land use and zoning at each of the interchanges by community.

Westford

Land use at Exit 32 (Boston Road) in Westford is primarily forested, residential and agricultural to the north of I-495. The major commercial area within the Town of Westford, comprised of a series of strip malls and free-standing commercial buildings, is located to the south of I-495 on State Route 110 (Littleton Road) at the intersection of Boston Road. Industrial uses (primarily office parks) as well as scattered commercial development continue in either direction along State Route 110. (See Figure B-4.) Almost the entire State Route 110 corridor within one mile of the interchange is zoned Industrial, comprising an area of 402 acres. (See

[1] MassGIS Land Use Summary Statistics, 1999 data

Figure B-5.) Of this, about half (221 acres) has been developed for industrial and commercial uses, with the remainder available for future development.

Chelmsford

Three of the study area interchanges are located within the Town of Chelmsford: Exit 33, providing access to State Route 4; Exit 34, providing access to State Route 110 (Chelmsford Street); and Exit 35 on the Lowell border, providing access to U.S. Route 3 and the Lowell Connector from northbound I-495. As in Westford, land use to the north of I-495 is primarily residential. Commercial uses are clustered along State Route 4 and State Route 110. Industrial land use in Chelmsford is primarily centered on State Route 129 (Billerica Road) along the U.S. Route 3 corridor. (See Figures B-6, B-7, and B-8.) Commuter traffic from I-495 uses State Route 4 (Exit 33) or Golden Cove Road via State Route 110 (Exit 34) to access the State Route 129 industrial area.

The State Route 110 corridor is zoned primarily for commercial use, much of which has already been developed. The U.S. Route 3 corridor in Chelmsford has been zoned industrial. (See Figures B-9, B-10, and B-11.) A block of industrially zoned land south of I-495 near Exit 35 remains undeveloped; however, this area is traversed by River Meadow Brook and contains wetlands and protected species habitats, limiting its development potential.

Lowell

I-495 skirts the edge of Lowell, with access to the city provided by the Lowell Connector via Exits 35 and 36, and via Woburn Street at Exit 37. Exits 38 and 39 in Tewksbury also provide access to Lowell.

Much of the area at the intersection of I-495 and U.S. Route 3, as well as along the Lowell Connector is zoned industrial. (See Figure B-13.) The CrossPoint development, located to the north of I-495 near Exits 35 and 36 between U.S. Route 3 and the Lowell Connector, contains 1.2 million square feet of office space and represents the largest concentration of employment in Lowell in close proximity to I-495. (See Figure B-12.) Significant future development potential exists at CrossPoint, although 2001 plans for an additional office tower were put on hold due to market conditions.

The land use adjacent to the Exit 37 interchange is primarily residential. However, Woburn Street provides access to industrial and office development in Tewksbury and Billerica (see Figures B-14 and B-15), as well as to the MBTA commuter rail station in North Billerica.

Table 2-12
Land Use

Land Use	I-495 Study Area Communities													Total	Percent
	Westford (acres)	Chelmsford (acres)	Billerica (acres)	Lowell (acres)	Tewksbury (acres)	Andover (acres)	Lawrence (acres)	North Andover (acres)	Methuen (acres)	Haverhill (acres)	Merrimac (acres)	Amesbury (acres)	Salisbury (acres)		
Agriculture1	624	447	324	80	477	519	7	1,108	671	2,182	592	1,108	559	**8,698**	4.9%
Forest	9,562	3,625	5,486	1,106	4,275	7,901	308	8,571	4,187	8,180	2,844	3,161	3,675	**62,881**	35.5%
Wetlands2	791	463	603	92	741	644	11	325	858	505	172	186	2,689	**8,080**	4.6%
Industrial3	772	653	1,246	848	600	899	694	568	457	638	71	258	220	**7,924**	4.5%
Open Land4	766	654	818	1,024	1,099	1,077	478	571	1,072	1,583	152	499	355	**10,148**	5.7%
Recreation5	289	206	257	312	278	557	142	229	335	568	11	187	233	**3,604**	2.0%
Residential6	6,234	7,306	7,038	4,516	5,315	7,365	2,243	4,946	5,930	6,504	1,457	2,169	1,620	**62,643**	35.4%
Commercial	182	426	329	514	350	417	426	276	338	473	50	126	271	**4,178**	2.4%
Transportation	227	619	400	317	198	469	161	310	463	596	120	217	178	**4,275**	2.4%
Water	620	377	341	496	193	547	7	719	85	722	94	500	0	**4,701**	2.7%
Total	**20,067**	**14,776**	**16,842**	**9,305**	**13,526**	**20,395**	**4,477**	**17,623**	**14,396**	**21,951**	**5,563**	**8,411**	**9,800**	**177,132**	**100.0%**

Source: Office of Geographic and Environmental Information (Mass GIS)
Notes:
1. Agriculture includes MassGIS land use categories: 1-Cropland, 2-Pasture, and 21-Woody Perennial
2. Wetlands includes MassGIS land use categories: 4-Nonforested Freshwater Wetlands and 14-Salt Wetlands.
3. Industrial includes MassGIS land use categories: 5-Mining, 16-Industrial, and 19-Waste Disposal.
4. Open Land includes MassGIS land use categories: 6-Open Land and 17-Urban Land.
5. Recreation includes MassGIS land use categories: 7-Participation Recreation, 8-Spectator Recreation, and 9-Water Based Recreation.
6. Residential includes MassGIS land use categories: 10-Multi-Family, 11-High Density, 12-Medium Density, and 13-Low Density.

Table 2-13
Potential Additional Development within the I-495 Corridor Communities

	Additional Residential Units	Additional Developable Land Area (acres)	Additional Commercial/Industrial Buildable Floor Area (million sq ft)
Westford	4,637	6,727	17.96
Chelmsford	1053	1756	6.07
Billerica	1,748	2,515	18.20
Lowell	5,495	1,238	23.72
Tewksbury	1,268	1,712	4.72
Andover	3,590	4,743	17.71
Lawrence	706	211	1.60
North Andover	2,324	2,583	8.37
Methuen	1,723	3,081	10.25
Haverhill	6,838	6,844	17.21
Merrimac	606	1,477	2.45
Amesbury	3,094	2,169	7.05
Salisbury	1,125	2,401	5.83
Total	**34,207**	**37,457**	**141.14**

Source: Executive Office of Environmental Affairs (EOEA) Community Preservation Initiative Buildout Analysis Summary, 2001

Tewksbury

Exit 38 provides access to State Route 38 in Tewksbury and Lowell. Land use adjacent to the interchange is primarily commercial, with commercial and industrial land uses extending in each direction along State Route 38. The remainder of the area within one mile of the interchange is a mix of residential and forested land uses. (See Figure B-16.) Much of the State Route 38 corridor is zoned commercial. There is a significant amount of industrially zoned land around the interchange, extending along the south side of I-495 to Exit 39. (See Figure B-17.)

Exit 39 is located on the Tewskbury/Andover town line providing access to State Route 133. There are a number of industrial and office parks located in the Tewksbury area, with industrial land uses located along the northwest quadrant of the interchange, and extending along either side of I-495 to the south. Ames Pond is located in the southeast quadrant of the interchange. Residential and forested land uses are predominating in the remainder of the one-mile area around the interchange. (See Figures B-18 and B-19.)

Andover

The I-495 interchange with I-93 (Exit 40) is located within the Town of Andover. Land uses adjacent to this interchange are primarily forest, wetland, and residential. (See Figure B-20.) No access to local streets is provided at this location, and there is very little industrial or commercial land use within the

vicinity of this interchange. Almost all of the area within one mile of this interchange is zoned residential. (See Figure B-21.)

Exit 41, located near the Lawrence city line, provides access to State Route 28. Most of the area within one mile of the interchange has been developed. Land use immediately adjacent to the interchange is primarily residential, with an area of wetland located along the southeast quadrant. The MBTA Haverhill line tracks pass under I-495 to the east of the interchange, with industrial land uses within one mile of Exit 41 located primarily along the rail line. (See Figure B-22.) The zoning is consistent with the existing land use pattern. (See Figure B-23.)

Lawrence

Three of the study corridor interchanges are located in Lawrence. Exit 42 provides access to State Route 114 in Lawrence and North Andover. Land use adjacent to the interchange is primarily commercial, although there is a residential neighborhood adjacent to the southbound I-495 on-ramp. Land use and zoning within one mile of the interchange is primarily residential, with an area of forested land and wetlands along the Shawsheen River to the east of I-495 between Exit 41 and Exit 43, which is located in North Andover. (See Figures B-24 and B-25.)

Exit 44 provides access to Merrimack Street in Lawrence and Sutton Street in North Andover. The Merrimack Street corridor contains numerous traditional mill buildings, which have been classified as an industrial land use. However, many of these mill buildings are being redeveloped for mixed commercial, office, and residential uses. A new MBTA commuter rail station and parking garage was opened in 2005 at the corner of Merrimack and Union Streets, approximately 0.75 miles west of the interchange. Sutton Street contains a mix of commercial and residential uses, and provides access to the Lawrence Municipal Airport (located in North Andover) and associated industrial park. (See Figures B-26 and B-27.)

Land uses adjacent to the interchange include industrial and open land to the west of I-495, commercial land to the southeast, and forested land to the northeast along the Merrimack River.

Exit 45 is located on the north side of the Merrimack River, providing access to Marston Street and downtown Lawrence. The river is located on the east side of interchange, with residential and industrial land uses to the west side of the interchange. (See Figures B-28 and B-29.)

North Andover

Located in North Andover on the border with Lawrence, Exit 43 provides access to Massachusetts Avenue (North Andover) and Loring Street (Lawrence). Land use adjacent to the interchange is primarily residential, with commercial land use adjacent to the I-495 southbound off-ramp, and forest land and the Shawsheen

River adjacent to the I-495 southbound on-ramp. The Shawsheen River crosses under I-495 just to the south of Exit 43. (See Figures B-30 and B-31.)

Methuen

In Methuen, the I-495 corridor is primarily residential. Exit 46 provides access to State Route 110 and to Holy Family Hospital, which is a major employer in Methuen. Land use immediately adjacent to the interchange on the east is primarily commercial, with another area of commercial land located on State Route 110 adjacent to the southbound I-495 off-ramp. Most of the area within one mile of the interchange in Methuen has been developed, primarily for residential use. (See Figures B-32 and B-33.)

Exit 47 provides access to State Route 213, a limited-access highway providing a connection between I-495 and I-93. Land use adjacent to the interchange is primarily residential, with an area of forest land adjacent to the State Route 213 on-ramp from I-495 southbound. (See Figure B-34.) One mile west of the interchange are approximately 50 acres of available land across from the Methuen Mall that is zoned commercial, offering the potential for additional large-scale commercial development such as a shopping mall near. In addition, there is an area of industrially zoned land to the north of State Route 213, and currently forested land bordering I-495 on the west offering the potential for additional industrial development near Exit 47. (See Figure B-35.)

Haverhill

Exit 48 in Haverhill provides access to the State Route 125 Connector. Land use adjacent to the interchange is primarily industrial on the east and forested and agricultural land on the west. (See Figure B-36.) All of the land abutting Exit 48 and the State Route 125 connector is zoned industrial, offering the potential for a significant amount of future development that would access this interchange. (See Figure B-37.)

Exit 49 provides access to State Route 110/113 (River Street). Land uses immediately adjacent to the interchange are commercial in the northeast quadrant, with open and recreational land adjacent to the Merrimack River in the southeast quadrant. On the west side of I-495, the predominant land uses are residential with a strip of forested land abutting the interstate in the southwest quadrant; and residential and open land, with a small area of commercial land in the northwest quadrant. (See Figure B-38.) There is a commercially zoned district adjacent to northbound I-495. However, most of the land appears to have been previously developed for commercial and recreational uses. (See Figure B-39.)

Exit 50 provides access to State Route 97 (Broadway). Land uses to the east of the highway are predominately residential, with an area of agricultural land in the northeast quadrant of the interchange. The southwest quadrant is primarily forested and open land. (See Figure B-40.) A large industrial-zoned district is

located to the west of I-495 along State Route 97. (See Figure B-41.) However, this area contains wetlands and protected species habitat, thereby limiting its potential for development. The east side of the highway corridor is residential. A recent large retail development near this interchange includes Lowe’s and Target stores.

Exit 51 provides access to State Route 125 (Main Street). Land use and zoning adjacent to, and within one mile of the interchange, is primarily residential. (See Figures B-42 and B-43.) I-495 crosses the Little River and associated forested and open land south of the interchange. A section of this forest land extends along the northbound I-495 off-ramp to State Route 125.

Exit 52 provides access to State Route 110 (Amesbury Road). Land use directly to the south of the interchange is primarily residential, with a small area of abutting commercial land use on State Route 110. An area of commercial land use along State Route 110 also abuts the interchange on the north side of I-495. The remainder of the area within one mile of the interchange is predominantly forest, residential, wetlands and surface water. Kenoza Lake is located to the south of the interchange. The southwest quadrant of the interchange is zoned commercial between State Route 108 and State Route 110. However, a portion of this commercial zoning district contains wetlands and protected species habitat, limiting its development potential. There is also an area of commercial zoning extending approximately 0.5 miles along State Route 110 to the north of the interchange. There is no industrial zoning within one mile of the interchange. (See Figures B-44 and B-45.) Exit 52 serves the Northern Essex Community College, which is a major trip generator and which is located about one mile from the interchange.

Merrimac

The Town of Merrimac contains one I-495 interchange, Exit 53, providing access to Broad Street. Land use to the south of the highway in the vicinity of the interchange is a mix of forest, residential and open land. Small areas of commercial and industrial land abut the interchange on the north, with the reminder of the area consisting of forest and residential land. Most of the area within one mile of Exit 53 is zoned residential, with much of the State Route 110 corridor, which runs parallel to I-495 on the north, zoned commercial. The area roughly bounded by I-495, Broad Street, the State Route 110 (East Street) commercial district, and the North Shore Trailer Park is zoned as other, which is an institutional use. (See Figures B-46 and B-47.)

Amesbury

The Town of Amesbury contains two interchanges that are approximately one mile apart, Exit 54 providing access to State Route 150, and Exit 55 providing access to State Route 110 at the Powwow River. Land use adjacent to Exit 54 is primarily forest, agricultural and open space, with an area of industrial land in the

southwest quadrant of the interchange. There is an area of open land containing a number of cemeteries to the northeast of the interchange. The land in the northwest and southwest quadrants of the interchange along State Route 150 is zoned commercial, with industrially zoned land along the south side of I-495 to the west of the commercial zone. There is also an area of industrially zoned land on the north side of State Route 110, to the northwest of the interchange. These areas of Commercial and Industrially zoned land indicate the potential for additional development that would access Exit 54. (See Figures B-48 and B-49.)

Land use adjacent to Exit 55 includes the Powwow River and associated wetlands and forested areas. Commercial land uses are located on State Route 110 to the west of the interchange, and residential land to the north. Industrial land uses are located to the north of I-495, along the border with the town of Salisbury. The zoning adjacent to the interchange, along State Route 110 to the Salisbury line and between I-495 and I-95 is commercial. (See Figures B-50 and B-51.) Areas of industrially zoned land are located to the north of I-495 along the Salisbury line, with another area of industrially zone land along the Powwow River in the center of Amesbury. The remainder of the area within one mile of the interchange is zoned residential.

2.3.3 Socio-Economics

2.3.3.1 Population and Households

The population of the thirteen study area corridor communities in 2000, based on census data, was approximately 491,000 people. The cities of Lowell, Lawrence, and Haverhill represent major population centers, containing almost half (48 percent) of the population of the study area. Suburban communities[1] in proximity to these population centers comprise another 46 percent of study area population. The three communities at the eastern end of the corridor—Merrimac, Amesbury, and Salisbury—are less developed and represent only 6 percent of the population within the study area. (See Figure B-52.)[2]

Based on 2025 population projections developed by the Northern Middlesex Council of Governments and the Merrimack Valley Regional Planning Commission, the population of the study area overall is expected to grow 13 percent by 2025, to a total of about 556,000 people. The cities of Lowell, Lawrence, and Haverhill are expected to remain as the major population centers, although their share of the regional population drops to 46 percent. The growth rate in Lowell is expected to be moderate (9 percent), with little growth in Lawrence (1 percent); however, the population of Haverhill is expected to grow at a rate of 20 percent, with 11,705 people added in the period of 2000-2025. Westford is expected to have the highest growth rate in the study area at 41 percent, with high rates of growth in Andover (28 percent), and North Andover

[1] Westford, Chelmsford, Billerica, Tewksbury, Andover, North Andover and Methuen
[2] Please see the Appendix, separately bound.

(23 percent). Merrimac, Amesbury, and Salisbury have some of the highest growth rates in the study area, but due to their smaller 2000 populations, are only expected to add about 9600 people in total.

Table 2-14 present a summary of existing and projected population growth in the I-495 corridor communities.

Table 2-14
Existing and Projected Population

Community	Population 2000	Population 2025	Percent Change	Total Change
Westford	20,754	29,350	41%	8,596
Chelmsford	33,858	36,900	9%	3,042
Billerica	38,981	41,650	7%	2,669
Lowell	105,167	112,010	7%	6,843
Tewksbury	28,851	32,500	13%	3,649
Andover	31,247	39,935	28%	8,688
Lawrence	72,043	72,623	1%	580
North Andover	27,202	33,352	23%	6,150
Methuen	43,789	47,404	8%	3,615
Haverhill	58,969	70,674	20%	11,705
Merrimac	6,138	7,619	24%	1,481
Amesbury	16,450	21,251	29%	4,801
Salisbury	7,827	10,636	36%	2,809
Total	**491,276**	**555,904**	**13%**	**64,628**

Source: Northern Middlesex Council of Governments (NMCOG) and the Merrimack Valley Regional Planning Commission (MVRPC)

The number of households in the study area is expected to increase by 18 percent in 2025 to 208,700. Household size is expected to decrease from an average of 2.77 persons/household in 2000 to 2.66 in 2025. The number of households is expected to increase in all communities, with the exception of Lawrence, which is expected to have fewer households in 2025. Trends in household growth parallel trends in population growth, with the largest number of households added in Haverhill, followed by Andover, Westford, Lowell, and North Andover, respectively. (See Figures B-53 and B-54)[1]

Table 2-15 presents a summary of existing and projected household growth in the I-495 corridor communities.

[1] Please see the Appendix, separately bound.

Table 2-15
Existing and Projected Households

Community	2000 Households	2025 Households	Percent Change	Total Change
Westford	6,808	10,846	59%	4,038
Chelmsford	12,812	14,232	11%	1,420
Billerica	12,919	15,215	18%	2,296
Lowell	37,887	41,570	10%	3,683
Tewksbury	9,964	12,048	21%	2,084
Andover	11,305	15,553	38%	4,248
Lawrence	24,463	23,080	-6%	-1,383
North Andover	9,724	12,553	29%	2,829
Methuen	16,532	18,905	14%	2,373
Haverhill	22,976	28,712	25%	5,736
Merrimac	2,233	2,925	31%	692
Amesbury	6,380	8,577	34%	2,197
Salisbury	3,082	4,491	46%	1,409
Total	**177,085**	**208,707**	**18%**	**31,622**

Source: NMCOG and MVPC

2.3.3.2 Employment

There were about 247,000 jobs within the I-495 corridor study area in 2000. (See Table 2-16.) The Town of Andover contains the most jobs in the region, followed by Lowell, Billerica, Lawrence, and Chelmsford. These five communities contain 61 percent of all employment within the study area. The eastern end of the corridor (Merrimac, Amesbury, and Salisbury) contains relatively few jobs, with total employment within the three communities representing only 4 percent of the employment in the study area. (See Figure B-55.)[1]

Employment is anticipated to grow about 16 percent by 2025, with about 39,700 jobs added to the region. Andover and Lowell are expected to remain as the most important employment centers in the corridor, followed by Haverhill, Billerica, and Lawrence; together constituting about 60 percent of the employment in the region in 2025. Haverhill and Westford are anticipated to have high rates of job creation, at 40 percent and 39 percent, respectively, in part because of the availability of industrially zoned land for development (See the discussion of land use in Section 2.3.2.) Merrimac, Amesbury, and Salisbury are also anticipated to have high rates of employment growth, but due to the small total number of existing jobs, total employment within these three communities is expected to remain at 4 percent of the employment in the study area. (See Figure B-56.)[1]

[1] Please see the Appendix, separately bound.

Table 2-16
Existing and Projected Employment

Community	2000 Employment	2025 Employment	Percent Change	Total Change
Westford	11,977	16,700	39%	4,723
Chelmsford	23,770	25,200	6%	1,430
Billerica	27,769	29,111	5%	1,342
Lowell	36,185	44,065	22%	7,880
Tewksbury	18,003	19,837	10%	1,834
Andover	37,363	44,460	19%	7,097
Lawrence	25,767	26,700	4%	933
North Andover	21,018	21,950	4%	932
Methuen	15,454	18,385	19%	2,931
Haverhill	20,897	29,245	40%	8,348
Merrimac	1,044	1,535	47%	491
Amesbury	5,206	6,201	19%	995
Salisbury	3,022	3,768	25%	746
Total	**247,475**	**287,157**	**16%**	**39,682**

Source: NMCOG and MVPC

2.3.4 Natural Environment

The following sections describe existing environmental constraints within the corridor that could potentially be affected by the alternatives developed to address transportation problems identified in the I-495 corridor. Documentation of environmental resources in the corridor was based on available MassGIS data. Figures B-57, B-58, and B-59[1] illustrate environmental resources throughout the corridor. Figures B-60 through B-82[1] indicate environmental resources present within one mile of each of the interchanges in the corridor study area.

2.3.4.1 Wetlands, Floodplains and Surface Waterbodies

The Merrimack River and its tributaries and associated wetlands and floodplain areas represent a significant environmental resource within the I-495 corridor study area. The highway crosses the Merrimack River in Lawrence between Exits 44 and 45, and again in Haverhill between Exits 47, 48, and 49, as well as numerous tributary streams and rivers throughout the corridor. Surface water bodies occupy a total of 2,094 acres (4 percent) of the area within one mile of the highway alignment, with wetlands occupying an additional 5,134 acres (10 percent). Floodplains occupy 6,158 acres (12 percent) and are often found coincident with wetlands and waterbodies. Additional information regarding wetlands, floodplains and surface waterbodies in the vicinity of the study area interchanges is presented below.

[1] Please see the Appendix, separately bound.

Westford – Andover (Exits 32-40)

An area of wetlands and floodplain abut the northbound on-ramp and southbound off-ramp and mainline at Exit 32 in Westford. Scattered wetland areas are located to the south of I-495 between Exits 33 and 34 in Chelmsford, although none appear to abut the interchange ramps themselves. I-495 crosses River Meadow Brook and associated floodplain west of Exit 35 in Chelmsford, and an unnamed tributary to River Meadow Brook and associated wetlands and floodplains to the east of Exit 36. The highway then crosses the Concord River and associated wetlands and floodplains on the Chelmsford/Lowell line. There are no surface water bodies or wetlands in proximity to Exit 37 in Lowell or Exit 38 in Tewksbury, but the highway again crosses a large wetland system known as the Great Swamp approximately 0.5 miles to the east of Exit 38. Ames Pond is located to the south of Exit 39 in Tewskbury, near the Andover town line. Fish Brook, with associated wetlands and floodplain, is located to the west of Exit 40 and I-93 in Andover, with Haggets Pond located approximately 0.5 miles southwest of the interchange.

Andover – Haverhill (Exits 41-51)

The highway crosses a tributary of Hussey Brook in Andover, approximately one mile east of Exit 40. The Shawsheen River and associated wetland and floodplain borders I-495 on the east between Exits 41 and 42. It then crosses under I-495 south of Exit 43, where it borders I-495 on the west until it reaches the Merrimack River in Lawrence at Exit 44. The highway crosses the Merrimack River between Exits 44 and 45, and abuts the river's floodplain up to the Lawrence/Methuen town line. At Exit 46, a wetland abuts the highway near the I-495 southbound off-ramp to State Route 110. Bare Meadow Brook, and associated wetlands and floodplain, are located in Methuen to the west of I-495 between Exit 47 and the Merrimack River. The highway then crosses the river twice to the south and once to the north of Exit 48. Wetlands have been mapped within the interchange ramps at Exit 48 and Exit 49. There is also a small unnamed stream located to the west of I-495 between the I-495 southbound on-ramp at Exit 48 and the Merrimack River. An unnamed tributary to Creek Brook, with associated wetlands and floodplain, are located between the I-495 northbound and southbound mainline in Haverhill, to the south of Exit 50. This brook extends through the southeast quadrant of the interchange. The highway then crosses the Little River, and associated wetlands and floodplains, to the south of Exit 51. However, there are no mapped wetlands in the immediate vicinity of the interchange.

Haverhill – Salisbury (Exits 52 – 55)

A large wetland is located in the northeast quadrant of the interchange at Exit 52 in Haverhill, and is crossed by the highway approximately 0.5 miles to the east of the interchange. At Exit 53 in Merrimac, wetlands are mapped on either side of the I-495 southbound off-ramp, although they do not appear to abut the ramp

itself. The highway crosses Cobbler Brook in Amesbury to the east of Exit 53. An unnamed stream flows under I-495 and the northbound ramps at Exit 54 in Amesbury. There are no mapped wetlands associated with this stream. Exit 55 in Amesbury abuts the Powwow River and associated wetlands and floodplain.

2.3.4.2 Public Water Supplies

At the western end of the corridor, I-495 overlies a groundwater aquifer in the vicinity of Exits 34 and 35. Several Chelmsford public water supply wells associated with this aquifer are located within one mile of I-495 to the south, including Riverneck Road Wells #1 and #2, Canal Street Wells #1, #2, and #3, and the Turnpike Road Well #1. I-495 crosses several smaller mapped aquifer areas in the remainder of the study area, but based on the MassGIS data, these aquifers do not have public water supply wells associated with them.

There area also a number of public surface water supplies within the I-495 study corridor, including Haggets Pond in Andover, located to the south of Exit 40; and Kenoza Lake and Round Pond in Haverhill, both located southwest of Exit 52.

2.3.4.3 Rare Species Habitat

Several protected species habitat areas have been identified within one mile of the study corridor, including the entire Merrimack River. I-495 is in proximity to the Merrimack River and associated protected species habitat in Lawrence between Exit 44 and the Methuen town line; in Methuen and Haverhill between Exits 47 and 49; and in Merrimac and Amesbury, between Exits 53 and 55. There is also a protected species habitat area adjacent to Exit 55 in Amesbury along the Powwow River, which is tributary to the Merrimack River.

At the western end of the corridor, a protected species habitat area associated with River Meadow Brook in Chelmsford is located on the south side of the highway corridor between Exits 34 and 35. A protected species habitat within the Great Swamp abuts I-495 on the south in Tewksbury between Exits 38 and 39. Another area of protected species habitat is located to the southwest of Exit 40 along Fish Brook between I-93 on the east and Haggets Pond on the west.

In the eastern part of the corridor, protected species habitat associated with wetlands to the north of Kenoza Lake abuts I-495 to the southwest of Exit 52. In addition, an area of protected species habitat, located in Amesbury between Exits 53 and 54, abuts I-495 on the north.

2.3.4.4 Historic Resources

The MassGIS database has identified numerous individual historic resources within one mile of the study corridor. However, none of these appear to be in

close enough proximity to the interchanges to be affected by any proposed improvements.

The only identified historic resource in close proximity to I-495 that could be affected by the proposed alternatives is the Chelmsford Center Historic District located along Boston Road (State Route 4) in Chelmsford, directly to the south of Exit 33.

2.4 Summary of Existing Conditions/Issues

I-495 Infrastructure

- The I-495 study corridor is approximately 40 miles long and contains 25 interchanges.
- Not including I-495's major interchanges with U.S. Route 3, I-93, and I-95, the study corridor contains 11 signalized intersections and 21 unsignalized intersections at the remaining interchanges.
- I-495 features three 12-foot travel lanes in each direction between Exit 32 in Westford and Exit 55 in Amesbury, with the remaining short section of roadway between Exit 55 and I-495's junction with I-95 having two 12-foot travel lanes in each direction.
- A total of 24 of I-495's acceleration and deceleration lanes at its interchanges are deficient with regard to length.

Traffic Volumes

- Large growth in traffic volumes has occurred since the highway opened in the 1960s, although growth had lessened in recent years. In some locations, daily traffic has grown by 20,000 or more vehicles over a 20-year period.
- Average weekday traffic volumes on I-495 currently range from 123,500 vehicles per day at the far end of the study corridor in Westford to 45,000 vehicles per day at the eastern end of the corridor in Amesbury.
- During the AM peak hour in the eastbound direction, volumes range from 5,100 vehicles in Westford to 1,300 in Amesbury. In the opposite westbound direction, they vary from 1,800 in Amesbury to 5,250 in Westford. For the PM peak hour in the eastbound direction, traffic volumes range from 4,700 in Westford to 1,750 in Amesbury. Westbound, PM peak hour volumes vary from 1,500 in Amesbury to 5,000 in Westford.
- Traffic volumes vary according to season, which can affect the quality of travel that motorists experience during certain times. However, planning and engineering for highway improvements is based on average conditions, not the seasonal peaks.

- I-495 plays an important role with regard to the movement of freight and goods. On a daily basis, trucks make up approximately 18 percent of the roadway's traffic.

Traffic Analyses

For purposes of the analysis of existing 2006 traffic conditions, the I-495 study corridor was divided into a Western Segment and an Eastern Segment, the boundary between the two being between Exits 40 and 41 in Andover.

Existing traffic operating conditions were examined from three perspectives: (1) signalized and unsignalized intersections at locations where ramps to and from I-495 meet the local street system, (2) merge, diverge, and weave movements at points along I-495 and (3) key links on I-495 between interchanges. In each case, level of service determination was made for both the existing AM and PM peak hour periods. In general LOS A through D conditions can be viewed as being uncongested and desirable, while LOS E and LOS F conditions can be viewed as congested and undesirable. Key results of these analyses of existing traffic conditions are as follows:

Intersections

- In the Western Segment in the AM peak hour, all six signalized intersections (100 percent) operate at LOS D or better overall, as do 42 (95 percent) of their 45 individual movements. For the six unsignalized intersections, 20 (87 percent) of their 23 individual movements currently operate at LOS D or better.

- For the Eastern Segment in the AM peak hour, all 5 signalized intersections operate at LOS D or better overall, as do 100 percent of their individual movements. The 15 unsignalized intersections contain a total of 63 movements that were analyzed, of which 59 movements (94 percent) operate at LOS D or better.

- During the PM peak in the Western Segment, all six signalized intersections currently operate at an overall LOS D or better, as do 39 (88 percent) of their 44 individual movements. At the six unsignalized intersections, 18 (78 percent) of their 23 individual movements operate at LOS D or better.

- In the Eastern Segment, all five signalized intersections (100 percent) operate at an overall LOS D or better, along with 33 (97 percent) of their 34 individual movements. The 15 unsignalized intersections have 54 movements (86 percent) of their total of 63 individual movements currently operating at LOS D or better.

Merge, Diverges, and Weaves

- In the Western Segment during the AM peak hour, 34 (89 percent) of the total of 38 of these types of movements currently operate at LOS D or better. Similarly, 61 (94 percent) of a total of 65 of these same types of movements in the Eastern Segment operate at LOS D or better.

- During the PM peak hour, 32 (84 percent) out of total of 38 of these types of movements in the Western Segment are currently operating at LOS D or better. In the Eastern Segment, 63 (97 percent) out of a total of 65 of these types of movements operate currently at LOS D or better.

Links

- All (100 percent) of the key links in the study area currently are operating at LOS D or better during both the AM and PM peak hours in both the Western and Eastern Segments of the study corridor.

Conclusion

The vast majority of I-495's signalized and unsignalized intersections with local streets at its interchanges; merge, diverge, and weave movements on the highway itself; and highway links between interchanges currently operate at uncongested LOS A through LOS D conditions.

Safety

- Records of crashes, organized by interchange were analyzed for the four-year period of 2002-2005. Crashes were categorized by type (property damage, injuries, fatalities), with interchanges ranked by each category. Exit 35 ranks first in terms of total number of crashes and crashes with property damage. Exit 32 ranks first with regard to personal injuries, while Exit 40 ranks first with regard to fatalities.
- The 24 acceleration and deceleration lanes on I-495 determined to be deficient in length present a safety concern.

Public Transportation

- Several forms of public transportation are available in the study corridor.
- Fixed-route local bus service in the Lowell and five surrounding communities is provided by the Lowell Regional Transit Authority. They also provide commuter bus, downtown shuttle and demand responsive paratransit services for the elderly and disabled. Similar services in Lawrence and eight nearby communities is provided by the Merrimack Valley Regional Transit Authority. Services provided by both agencies

are locally oriented and centered on the Lowell and Lawrence hubs, not along the I-495 corridor.

- The Massachusetts Bay Transportation Authority provides commuter rail service on its Lowell and Haverhill/Reading lines. This service is oriented toward Boston, not the I-495 corridor for the most part.
- Other providers of public transportation include AMTRAK, with its Boston to Portland service, stopping in Haverhill, and several intercity bus lines.
- Two transportation management associations, the Junction TMO and the Merrimack Valley TMA, provide carpool matching services to limited areas within the study corridor.
- Three Park & Ride lots are located in the study area. Two are served by public transportation.

Other

Although having no direct connection with this I-495 Corridor Planning Study, MassHighway has placed several projects along I-495 in the study area on its Type II Priority List for noise barrier implementation. These potential projects are located in Westford, Chelmsford, and Lowell. No timetable for their implementation has been developed by MassHighway. More details regarding these projects can be found in Appendix B.

3.0 Future No-Build Conditions

3.1 Introduction

Existing conditions along the Route I-495 project corridor were discussed in detail previously in Chapter 2 with regard to roadway infrastructure, traffic volumes, traffic operations, safety, public transportation, land use, socio-economics, and the environment. This chapter presents information on future year 2030 conditions along the corridor for several of these same topics.

The traffic discussion in this chapter assumes No-Build conditions. That is, it is assumed for purposes of discussion that no substantial improvements to the highway infrastructure, such as additional lanes, new interchanges, the introduction of signalization at unsignalized intersections, etc., will have been made between now and 2030.

3.2 Future No-Build Conditions

3.2.1 Transportation

This section discusses future transportation conditions within the I-495 study corridor with regard to traffic volumes, peak period operating conditions, and safety. Also included is a brief discussion of future proposed changes to public transportation services within the study area as contained in current regional transportation plans.

3.2.1.1 Traffic Volumes

Projections of future year weekday No-Build 2030 traffic volumes on I-495 itself and at its interchanges were provided by the Central Transportation Planning Staff (CTPS). These projections were derived by CTPS using their regional transportation model, modified as necessary to provide the detail needed for this particular study, including projections associated with specific known development in the study area. (See a CTPS memorandum on their regional transportation model in the Technical Appendix of this report.) It should be noted that regional transportation models such as this one are based on projections of future demographics, including population, employment, etc. If these inputs to the model should differ in the future from what was projected, then the results of the traffic model would also be affected. For example, the recent increases in gasoline prices were not considered when developing

the model. Should these higher prices persist over the long term, travel patterns and volumes could certainly be affected.

Projections of future traffic are produced and then analyzed so that future traffic issues can be identified. Once such issues are identified, a program of recommended improvements to be implemented in the future can be developed. These same projections of future traffic also provide indications of how long solutions developed in response to existing problems will remain effective.

Figures 3-1 and 3-2 illustrate the projected Average Weekday Daily Traffic (AWDT) on the I-495 main line as well as AM and PM peak period directional counts for 2030 Future No-Build conditions. The volumes shown on Figures 3-1 and 3-2 can be compared with those presented on Figures 2-3 and 2-4 respectively, in Chapter 2 to see how traffic is expected to grow at specific locations along the I-495 study corridor between now and 2030.

Figures 3-1 and 3-2 show that eastbound AWDT will vary from 72,600 in Westford at the study corridor's far western end to 30,000 in Amesbury at the study corridor's far eastern end. In the westbound direction, AWDT is projected to vary from 32,000 in Amesbury to 73,800 in Westford.

As under current conditions, the busiest section of I-495 in terms of AWDT traffic volumes will be in that section of the highway located in Lowell between Exits 36 and 37. Specifically, AWDT in this area is projected to be 77,000 eastbound and 78,000 westbound, for a total two-way AWDT of 155,000 vehicles per day. As a point of interest, existing (2006) two-way AWDT at this same location, which was also the location where AWDT was of greatest value under existing conditions, was shown in Chapter 2 to be 140,500 vehicles per day.

Year 2030 Future No-Build AM peak hour volumes in the eastbound direction range from 6,610 in the three-lane section of the highway in Westford to 1,880 in the two-lane section of the highway in Amesbury. In the westbound direction, they are projected to range from 2,450 in Amesbury to 5,890 in Westford. The highest eastbound AM peak hour volume is projected to occur west of Exit 32 in Westford, at 6,610 vehicles per hour. In the westbound direction during the AM peak hour, the highest volume will be 6,790 vehicles per hour between Exits 49 and 48 in Haverhill.

In the PM peak hour, eastbound volumes range from 5,250 in the three-lane section of the highway in Westford to 2,340 in the two-lane section of the highway in Amesbury. In the westbound direction, they range from 2,230 in Amesbury to 6,400 in Westford. The location with the highest PM peak hour volume in the eastbound direction is between Exit 48 and Exit 49 in Haverhill, where volume is estimated to be 6,610 vehicles per

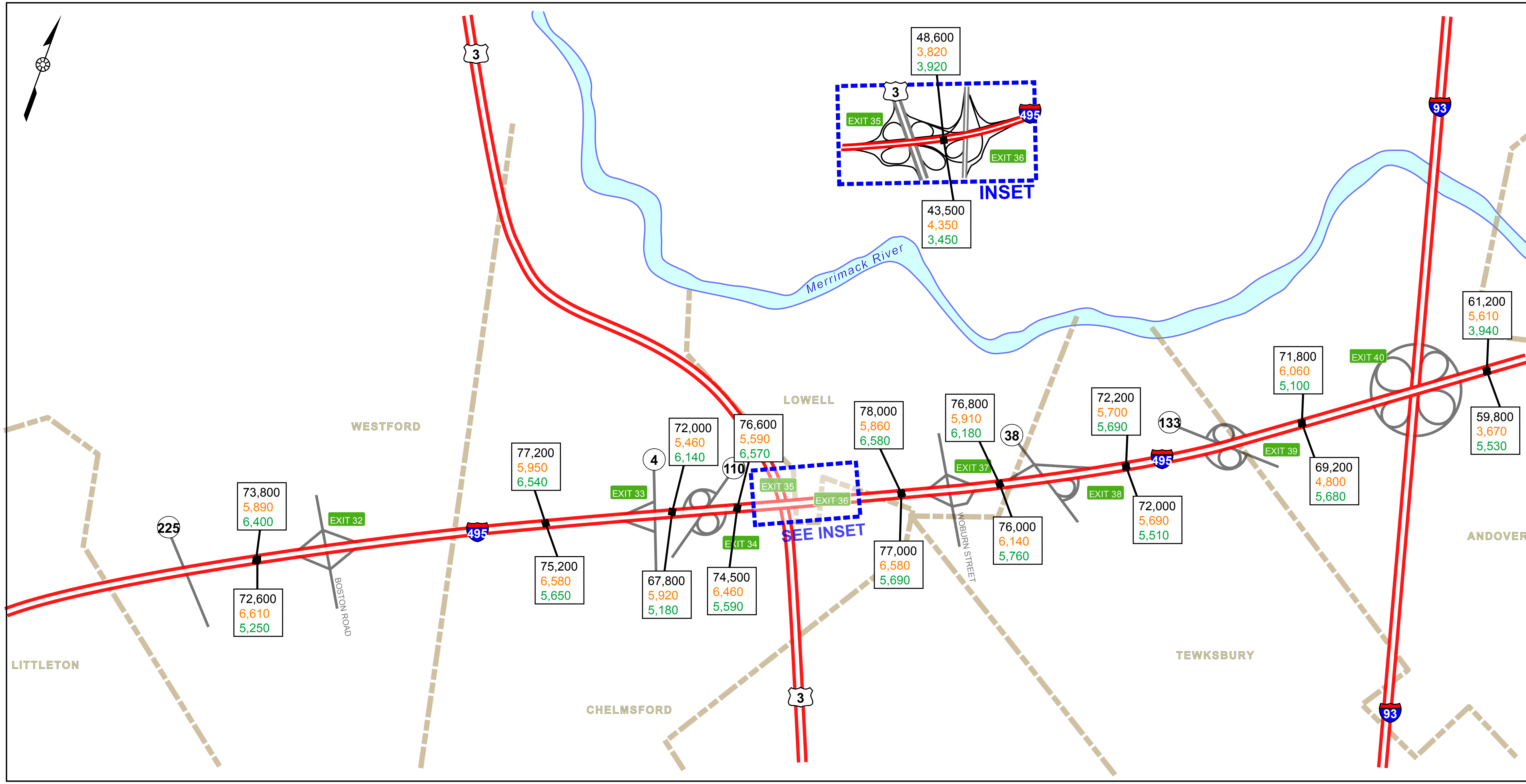
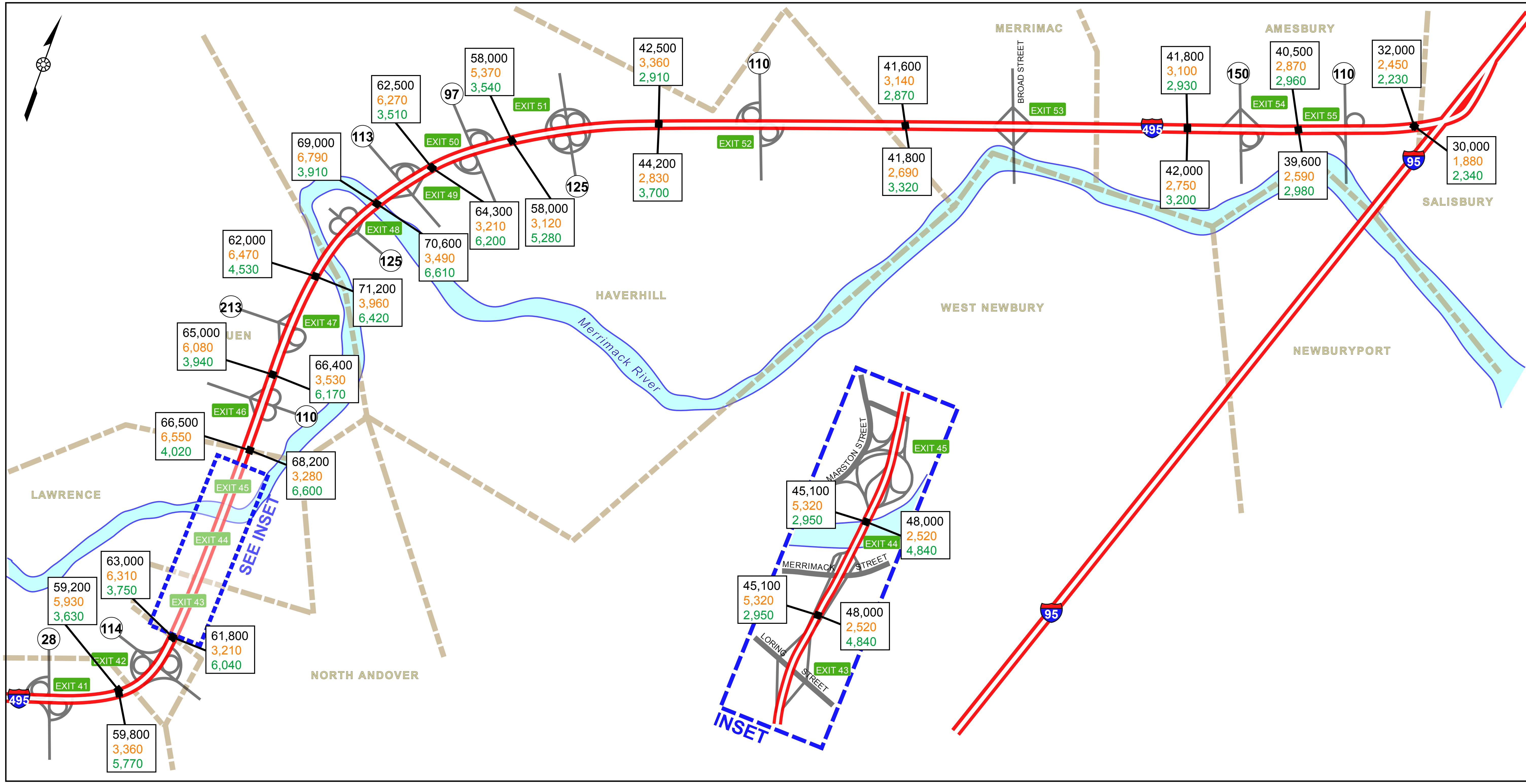


Figure 3-1*
2030 Average Weekday Daily Traffic and
AM and PM Peak Directional Volumes
Western Segment

Legend

Average Daily Traffic Volume
AM Peak Hour Directional Volume
PM Peak Hour Directional Volume

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



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Average Daily Traffic Volume
AM Peak Hour Directional Volume
PM Peak Hour Directional Volume

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

INTERSTATE 495

Figure 3-2*
2030 Average Weekday Daily Traffic and AM and PM Peak Directional Volumes
Eastern Segment

hour. Westbound, the location with the highest value will be between Exits 37 and 36 in Lowell, with a total of 6,580 vehicles per hour.

AM and PM peak hour turning movements at all of the interchanges along the I-495 study corridor are presented in Figures 3-3 through 3-6. Again, the volumes presented on these four Figures can be compared with those given on Figures 2-5 though 2-8 in Chapter 2 to observe projected traffic growth at specific locations along the study corridor.

3.2.1.2 Projected (2030) No-Build Peak Hour Traffic Operations

In this section, projected 2030 traffic operating conditions along the study corridor are briefly discussed with regard to levels of service at unsignalized and signalized intersections; at merge, diverge, and weave locations; and at key links on I-495 itself. The brief text discussions of these issues are accompanied by a series of Figures that graphically illustrate the projected levels of service resulting from the analyses undertaken.

For this No-Build traffic operations analysis it is assumed that no major improvements/changes to the roadway network/infrastructure will have been made between now and 2030 aside from those planned, underway, or listed on the Transportation Improvement Programs (TIP) of the study corridor's two regional planning agencies.

For those desiring more detailed information on the analyses results, please see Appendix C of this document. Tables in Appendix C present information with regard to not only level of service but also delays and queue length. Such information is provided on an individual-movement-within-an-intersection basis.

Intersections

Results of the analyses of future 2030 No-Build intersection levels of service are given in this section, first for the AM peak period and then for the PM peak period. As noted in Chapter 2, the intersections studied are located where I-495's on- and off-ramps meet the local street network.

<u>AM Peak Hour</u>

Figures 3-7 and 3-8 graphically illustrate projected 2030 AM peak hour levels of service for signalized and unsignalized intersections in the Western and Eastern Segments of the study corridor, respectively.

The Western Segment of the study corridor includes six interchanges with local streets, these being Exits 32 through 34 and Exits 37 through 39. These 6 interchanges are themselves comprised of a total of 12 intersections that are either signalized or stop-controlled and which were the subject of the analyses.

For the signalized intersections, Figure 3-7 shows that all six of them will continue to operate in the acceptable LOS A through LOS D range overall, as they did under existing 2006 conditions. When individual movements within these intersections were examined, the analysis showed that 40 movements (91 percent) of the total of 44 movements will operate in the LOS A through LOS D range, a decrease from 42 such movements (95 percent) for 2006. Of the four movements (9 percent) not in this range, there will be two at LOS E, one being at Exit 32 SB in Westford and the other at Exit 39 NB in Tewksbury. Unlike in 2006, by 2030 there will also be two movements at signalized intersections that will operate at LOS F. These two locations will be at Exit 32 NB in Westford and at Exit 39 SB in Tewksbury.

As stated in Chapter 2, unsignalized intersections do not receive an overall level of service determination, as do signalized intersections. Rather, only conflicting movements within such intersections are analyzed. Of the total of 23 such conflicting movements at the 6 unsignalized intersections in the Western Segment, 16 movements (70 percent) will continue to operate in the acceptable LOS A through LOS D range. In 2006, this percentage was 87 percent. Whereas in 2006 three movements (13 percent) were determined to be operating at LOS F, by 2030 there will be five movements (22 percent) at LOS F, namely, two at Exit 33 NB in Chelmsford, one at Exit 34 NB in Chelmsford, one at Exit 37 NB in Lowell, and one at Exit 37 SB in Lowell. In addition, by 2030 there will also be two movements (8 percent) operating under LOS E conditions. These two movements will be at Exit 34 SB in Chelmsford and at Exit 37 NB in Lowell.

With regard to signalized intersections in the Eastern Segment of the study corridor, it can be seen from Figure 3-8 that there are seven such intersections that were analyzed. Figure 3-8 also shows that all seven of these signalized intersections will operate in the desirable LOS A through LOS D range overall, as did all the signalized intersections in 2006. A total of 43 movements (98 percent) out of the 44 movements that these intersections contain will also operate in the desirable LOS A through LOS D range, the one exception being a left-turn movement at Exit 50 SB. It will operate at LOS F.

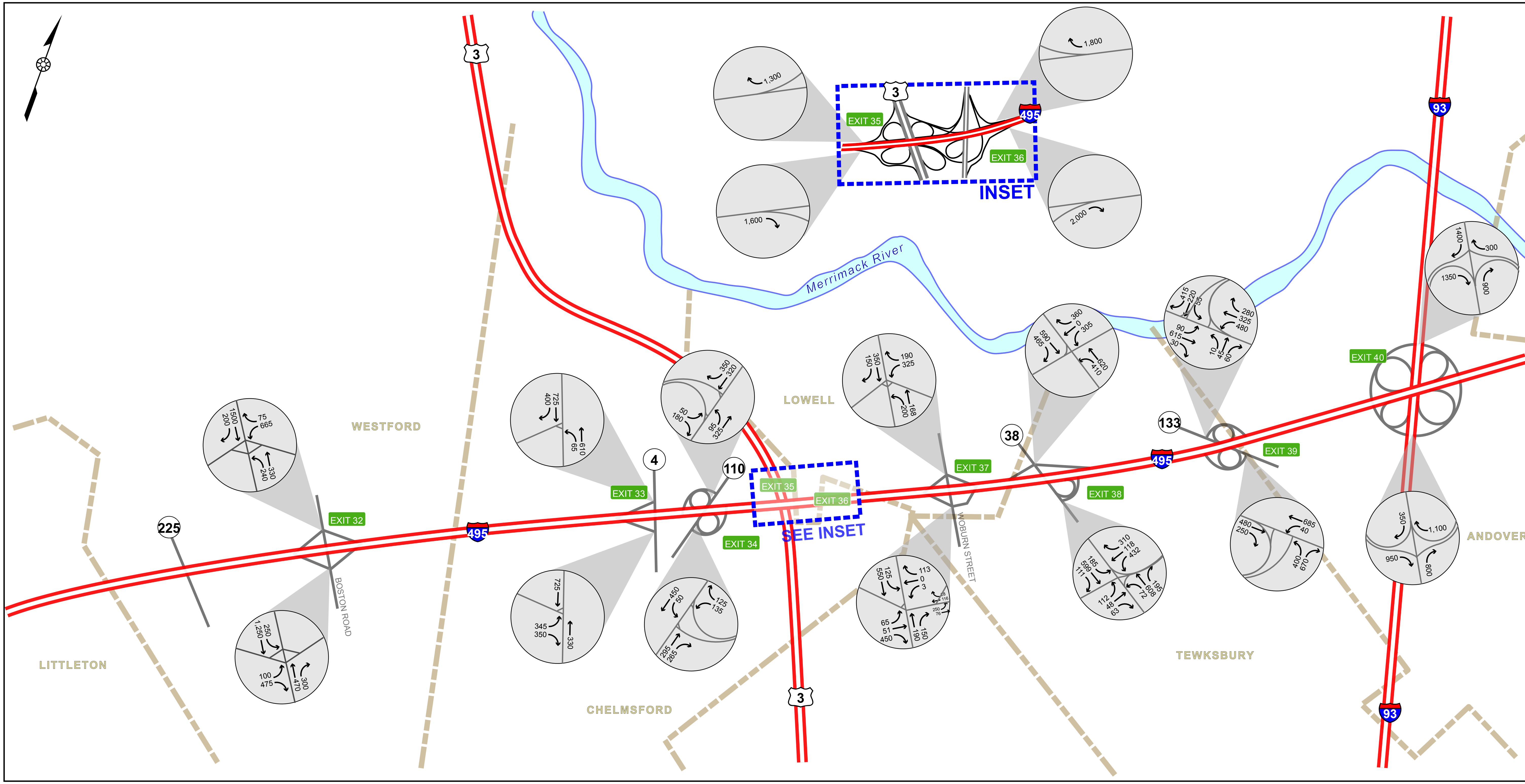


Figure 3-3*
2030 AM Peak Hour Turning Movement Volumes
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy of Environmental Affairs

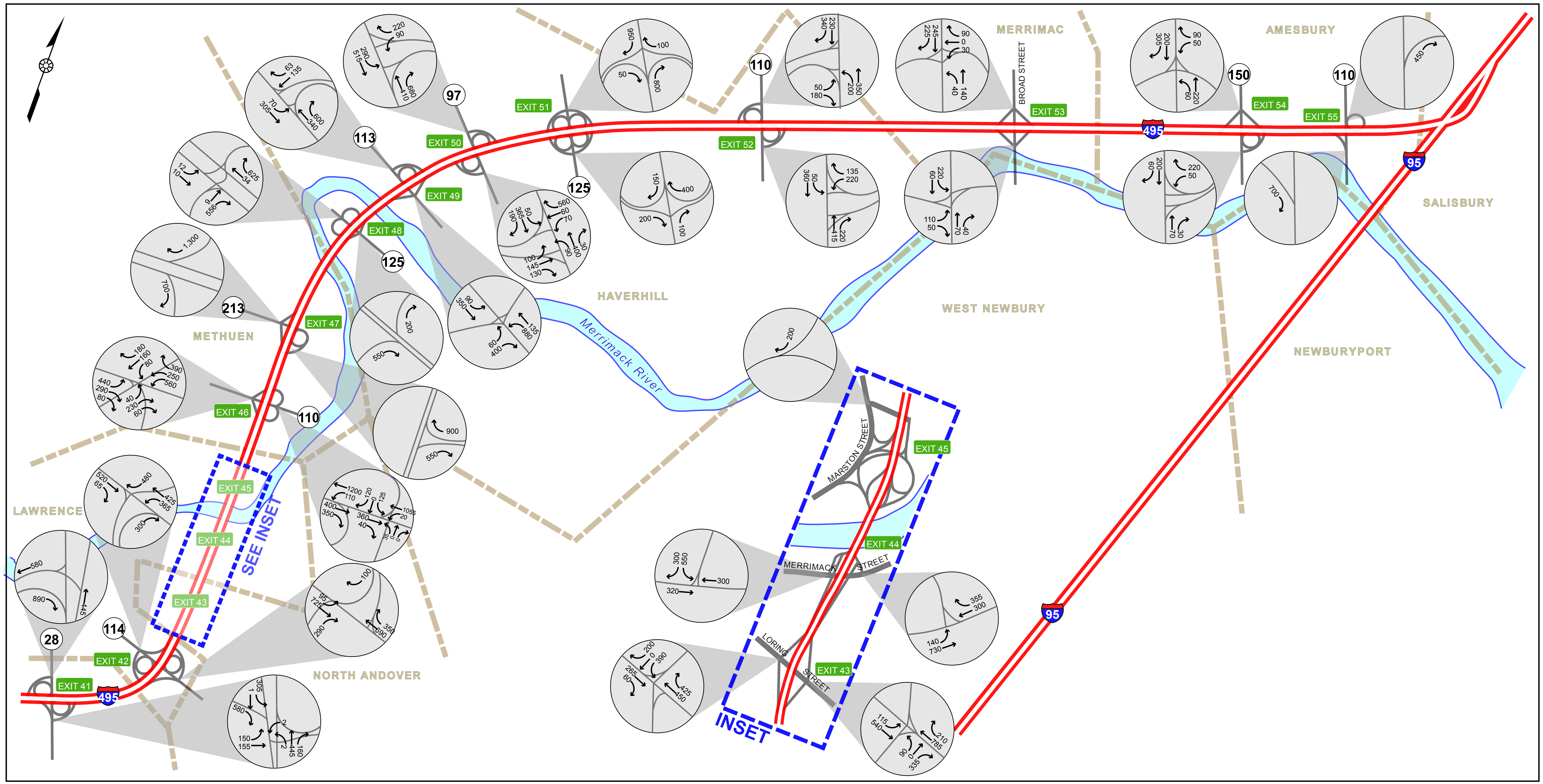


Figure 3-4*
2030 AM Peak Hour Turning Movement Volumes
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

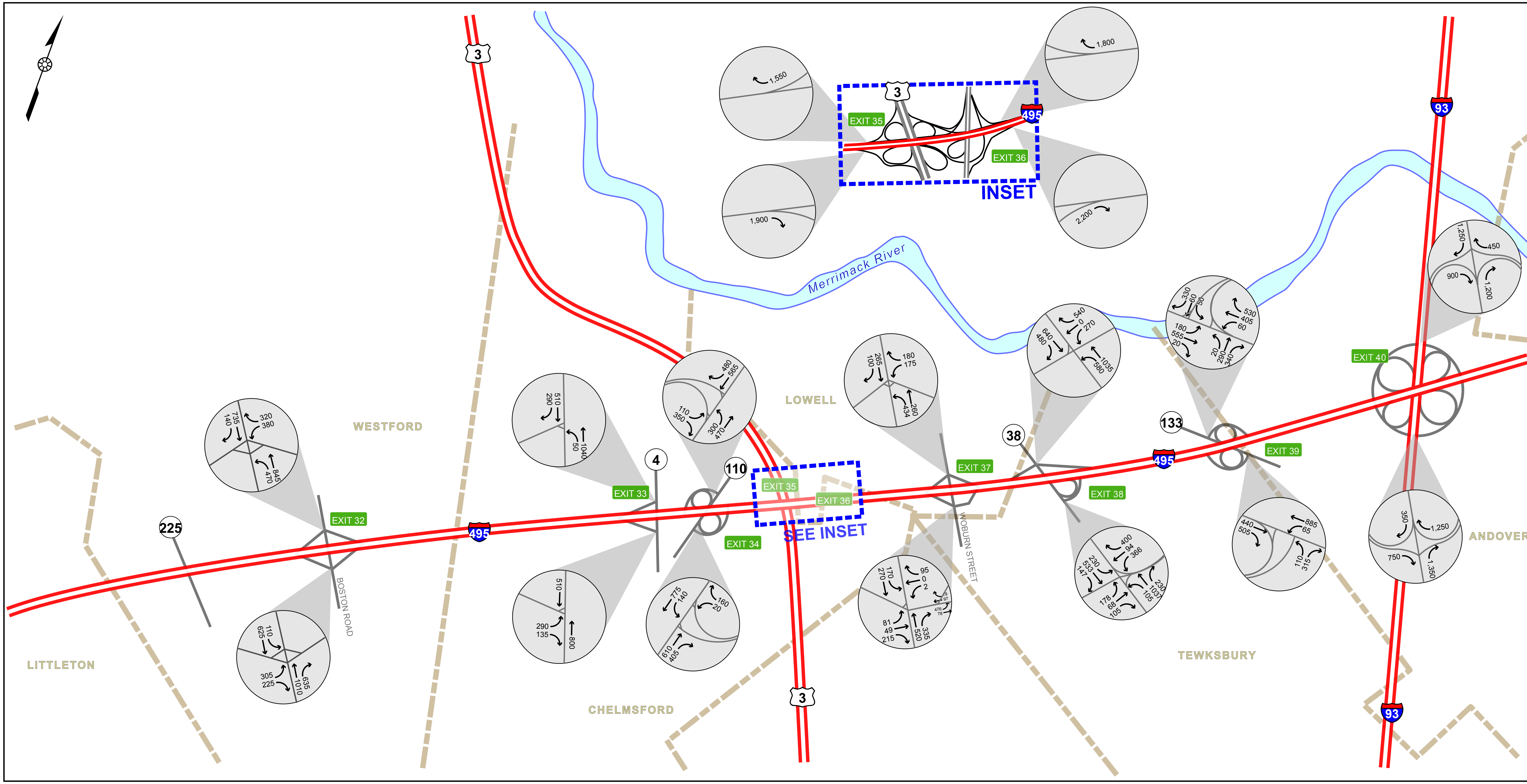


Figure 3 - 5*
2030 PM Peak Hour Turning Movement Volumes
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

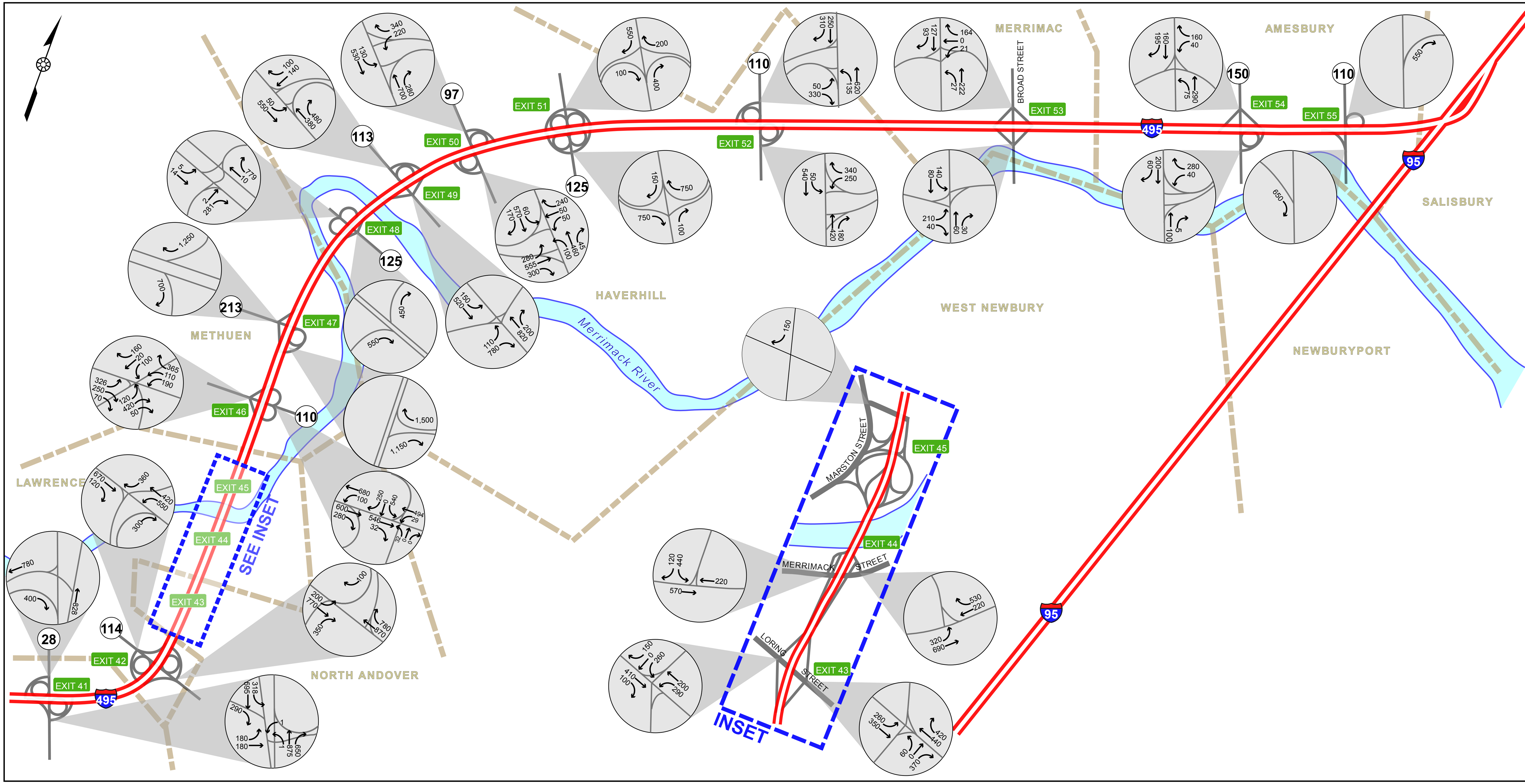
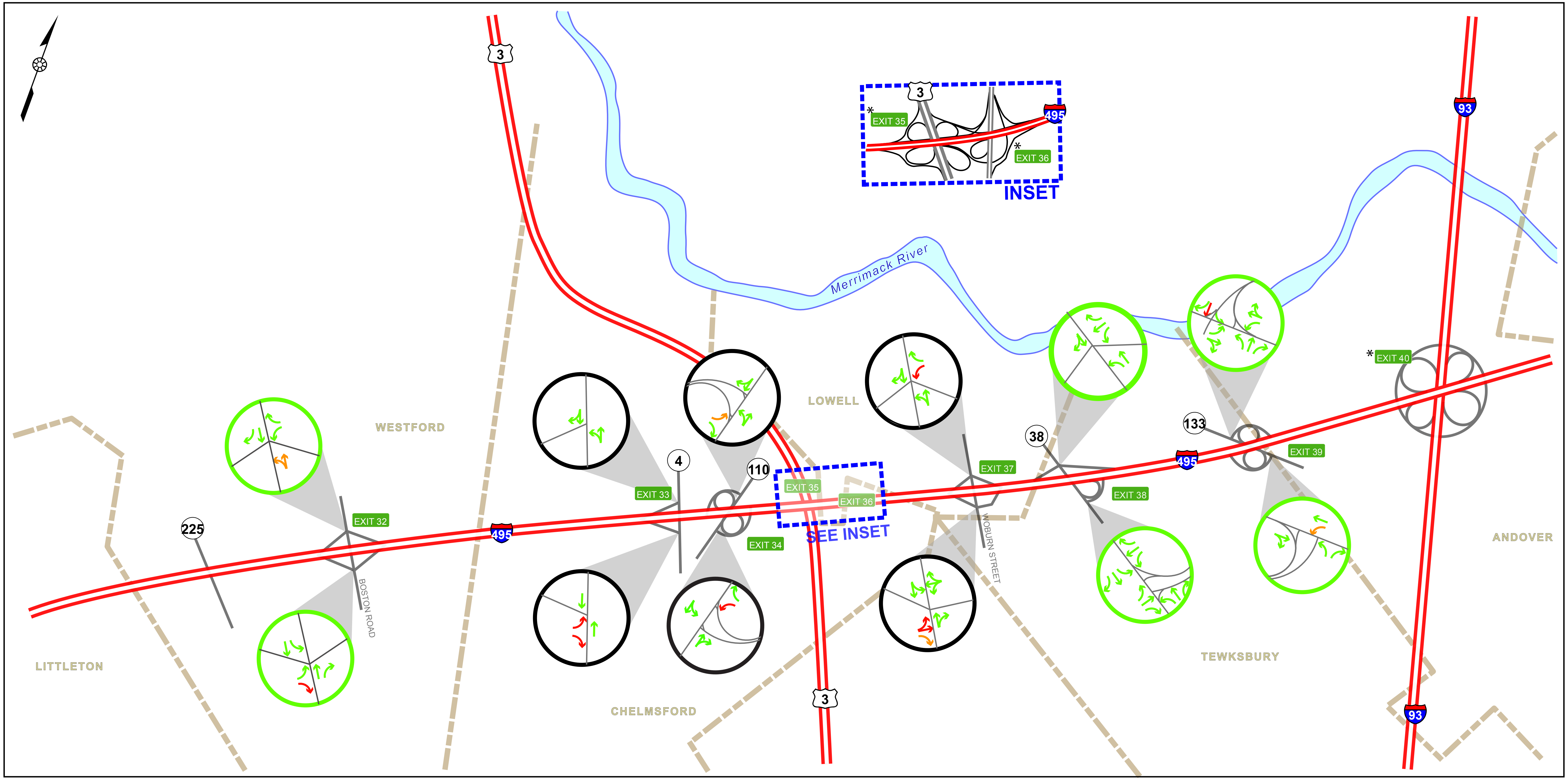


Figure 3 - 6*
2030 PM Peak Hour Turning Movement Volumes
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

LOS E

LOS F

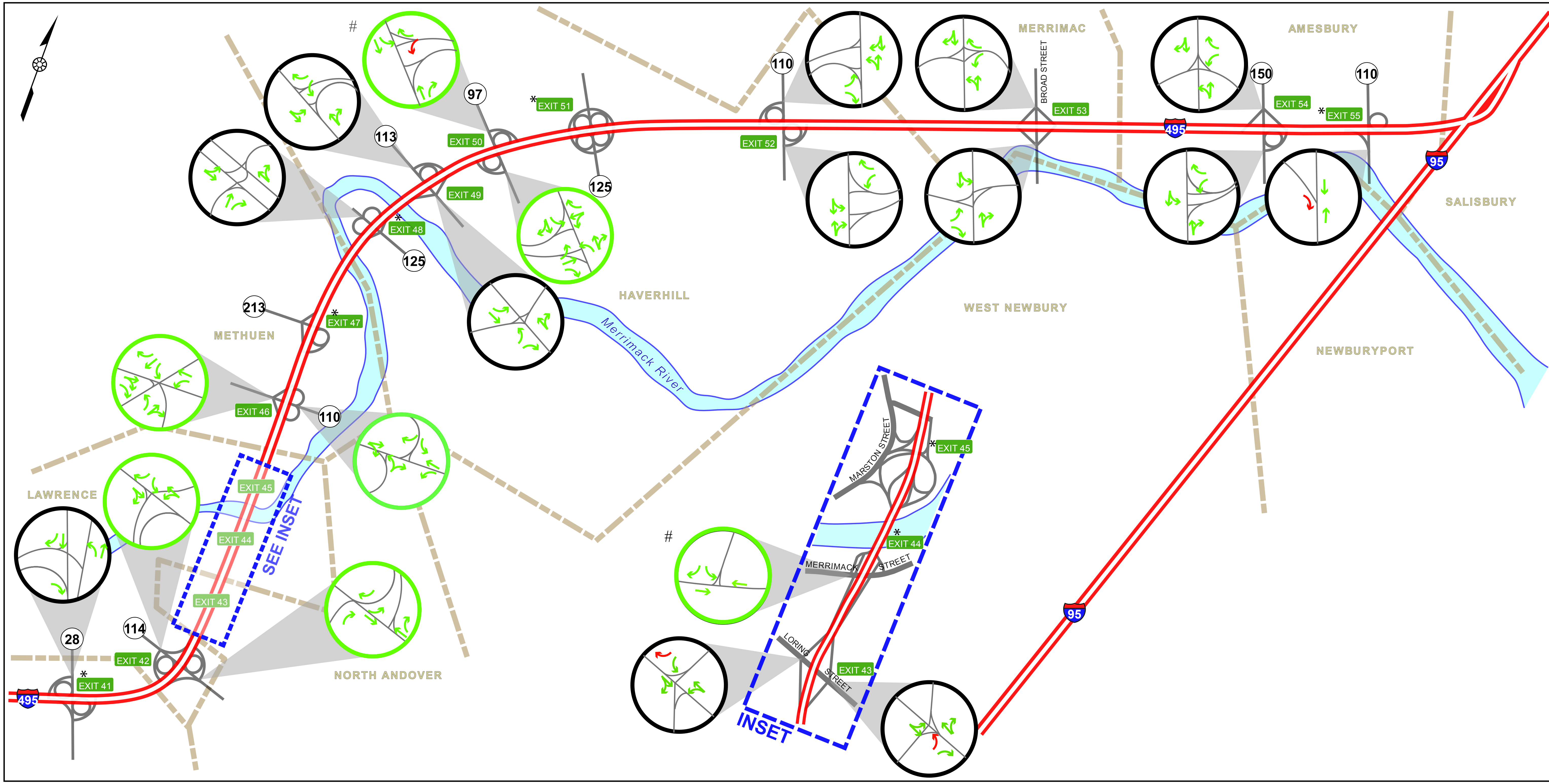
* Refer to Figure 2-13 for ramp operations

Figure 3-7*

2030 AM Peak Hour LOS Intersection Operations

Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

LOS E

LOS F

^ LOS was only calculated for intersections with stop and signal control

Intersection was signalized after data was collected for existing conditions. It is analyzed as an unsignalized intersection in the existing 2006 case.

Figure 3-8*
2030 AM Peak Hour LOS Intersection Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

The Eastern Segment of the I-495 study area corridor contains, as shown on Figure 3-8, a total of 13 unsignalized intersections with a total of 53 movements that were analyzed to determine projected levels of service. There will be a total of 50 movements (94 percent) that will operate in the acceptable LOS A though LOS D range in 2030. The remaining three movements (six percent) will operate with LOS F conditions in 2030. These three movements projected to have LOS F conditions are located at Exit 43 NB and Exit 43 SB in North Andover, and Exit 55 NB in Amesbury.

PM Peak Hour

Projected 2030 levels of service determinations for signalized and unsignalized intersections in the Western and Eastern Segments of the I-495 study corridor during the PM peak hour are graphically presented in Figures 3-9 and 3-10, respectively.

Figure 3-9 shows that all six signalized intersections in the Western Segment will, in 2030, continue to operate in the desirable LOS A through LOS D range overall, as they did in 2006. On an individual movement basis, 38 movements (86 percent) of the total of 44 movements at these 6 intersections will operate in the LOS A through LOS D range. This result represents a slight decrease from 39 movements (89 percent) in 2006. Specifically, four movements (9 percent) will operate at LOS E in 2030, these movements being located at Exits 38 NB and 38 SB in Tewksbury. In 2006, there were only three such movements, all located at Exit 38 NB. The same 2 movements (5 percent) out of a total of 44 movements that were operating at LOS F in 2006 will continue to do so in 2030. These two movements are located at Exit 39 SB in Tewksbury.

For the six unsignalized intersections in the Western Segment during PM peak hour, the percentage of movements that will operate in the desirable LOS A through LOS D range will decrease from 78 percent in 2006 to 74 percent as the result of there being one more movement operating at LOS E in 2030 than in 2006. This additional movement is located at Exit 34 SB in Chelmsford, as can be seen from Figure 3-9. The five intersection turning movements at the six intersections that operated at LOS E or LOS F in 2006 will each continue to operate at exactly those same levels of service in 2030.

In the Eastern Segment of the study corridor during the PM peak hour, as shown on Figure 3-10, six (86 percent) of the seven intersections analyzed as being signalized for 2030 will operate in the desirable LOS A through LOS D range overall. At Exit 46 SB in Methuen, one combined movement will within that intersection will operate at LOS E, while at Exit 50 SB in Haverhill, one movement in that intersection will operate at LOS E and another at LOS F. The remaining signalized intersection, that at Exit 46 NB in Methuen, will have deteriorated in overall level of service

such that it will operate at LOS F by 2030, having been in the desirable LOS A through LOS D range in 2006. One individual movement within this intersection, a right-turn movement at the end of the ramp will also operate at LOS F.

The 13 intersections analyzed as being unsignalized in 2030 contain a total of 53 movements, as noted previously. It was determined from the analysis that 45 movements (85 percent) will operate at LOS D or better. Of the remaining 8 movements (15 percent), 3 will operate at LOS E. These three movements will be located at Exit 41 SB in Andover, Exit 49 NB in Haverhill, and Exit 52 NB in Haverhill. The remaining five movements will operate at LOS F. They will be located at Exits 43 NB and 43 SB in North Andover, Exits 49 NB and 49 SB in Haverhill, Exit 50 SB in Haverhill, and Exit 55 NB in Amesbury.

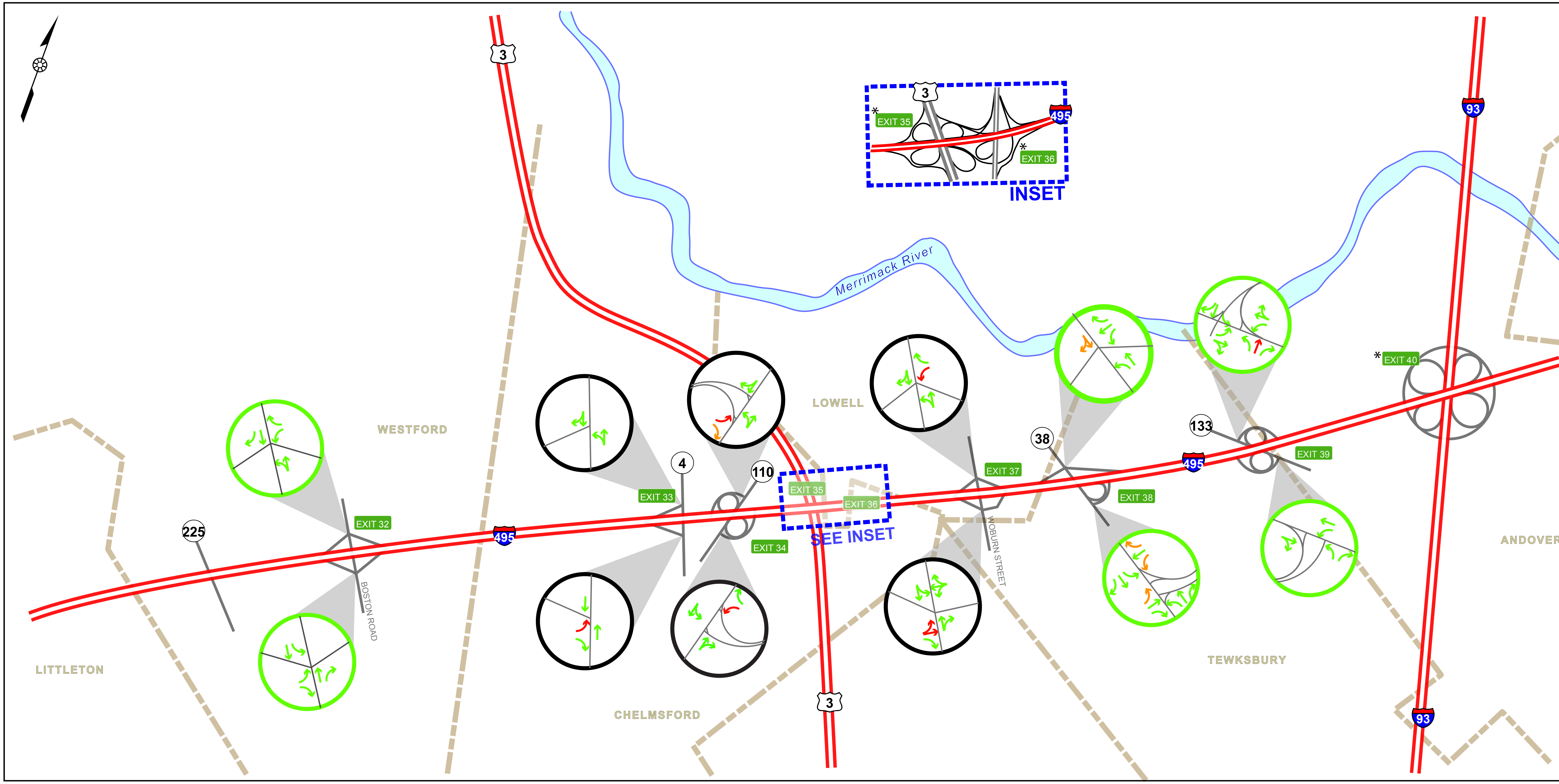
Merges, Diverges, and Weaves

This section presents the results of analyses performed to determine 2030 levels of service for merge, diverge, and weave movements along the I-495 study corridor.

<u>AM Peak Hour</u>

Figures 3-11 and 3-12 visually display the analysis results for the Western Segment and the Eastern Segment of the study corridor, respectively, for the 2030 AM peak hour. Results for both directions of the highway are shown on the Figures. As Figure 3-11 shows, the analyses of the total of 38 merge/diverge/weave movements examined in the Western Segment revealed that 25 locations (66 percent) will operate in the desirable LOS A through LOS D range during the 2030 AM peak hour, as compared with 34 locations (89 percent) during the AM peak hour in 2006. There will be 13 movements—5 diverges, 4 merges, and 4 weaves—that will experience LOS F conditions, but no movements at LOS E. Merge movements at LOS F in 2030 will be at Exit 32 NB in Westford, Exit 36 NB in Lowell, Exit 37 NB in Lowell, and Exit 40 SB in Andover. The diverge movements that will be at LOS F will be located at Exit 32 NB in Westford, Exit 33 NB in Westford, Exit 34 SB in Chelmsford, and Exit 37 NB in Lowell. Finally, weave movements at LOS F will be at or near Exits 34-35 in Chelmsford and Exit 40 in Andover.

Noteworthy is the fact that the majority of the merge/diverge/weave locations in the Western Segment of the study corridor that are predicted to operate at LOS F can be found along the eastbound side of the highway, corresponding to the predominant direction of traffic flow during the time of the AM peak period (see Figure 3-1).



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

LOS E

LOS F

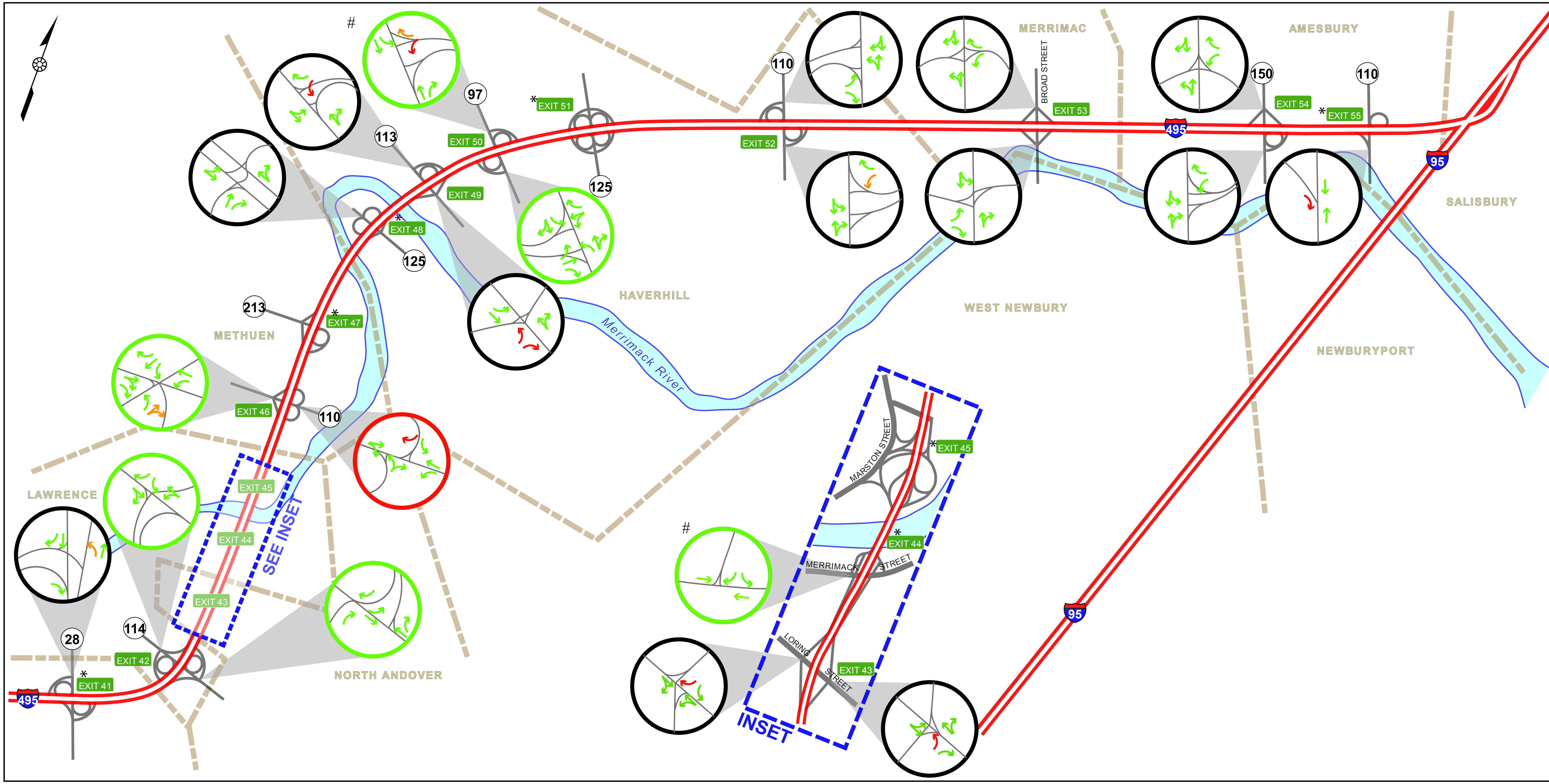
* Refer to Figure 2-13 for ramp operations

Figure 3-9*

2030 PM Peak Hour LOS Intersection Operations

Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

LOS E

LOS F

^ LOS was only calculated for intersections with stop and signal control

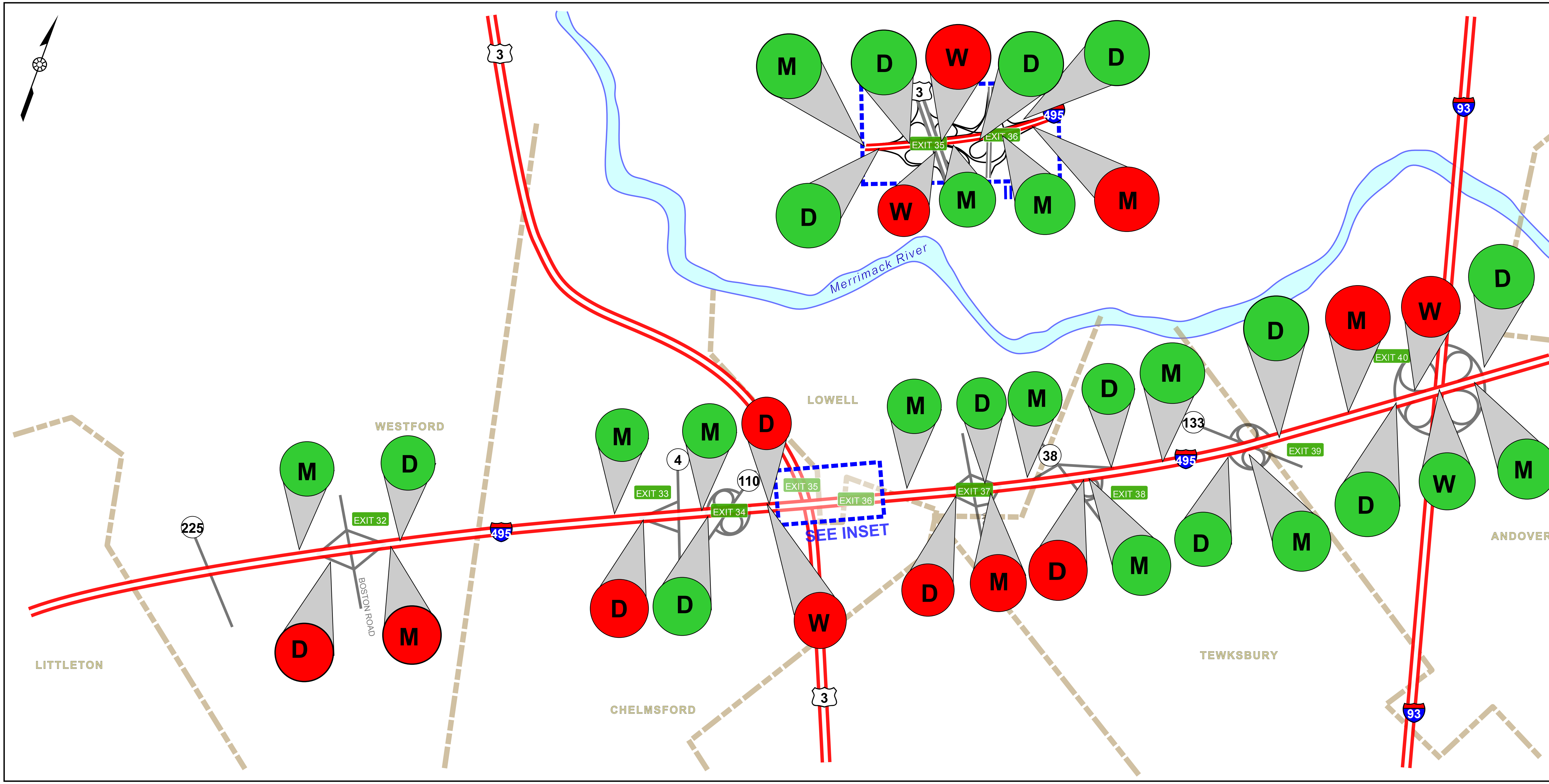
Intersection was signalized after data was collected for existing conditions. It is analyzed as an unsignalized intersection in the existing 2006 case.

Figure 3-10*

2030 PM Peak Hour LOS Intersection Operations

Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

	LOS A - D	**D**	Diverge
	LOS E	**M**	Merge
	LOS F	**W**	Weave

Figure 3-11*
2030 AM Peak Hour Ramp Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

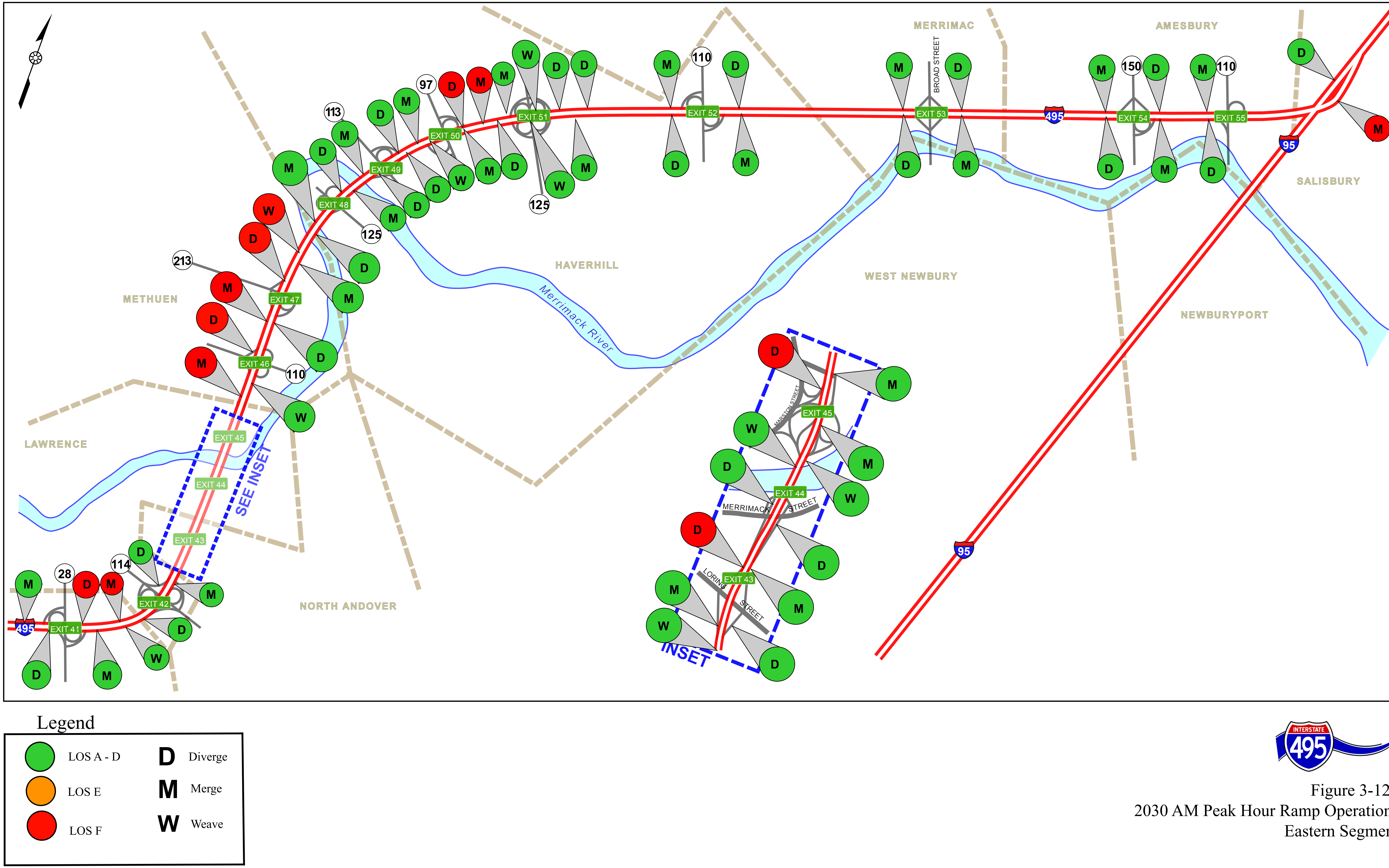


Figure 3-12*
2030 AM Peak Hour Ramp Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

The results of the merge/diverge/weave analyses for the AM peak hour in the Eastern Segment of the I-495 study corridor are illustrated on Figure 3-12. In the Eastern Segment of the corridor, a total of 65 merge/diverge/weave movements was studied. Of this total, it was determined that 53 movements (83 percent) will operate in the desirable LOS A through LOS D range, as compared with 61 movements (94 percent) in 2006. A total of 11 movements (17 percent) will operate at LOS F, and are comprised of 5 merges, 5 diverges, and 1 weave. No movements will operate at LOS E. These 5 merges will be located at Exit 42 SB in Lawrence, Exit 46 SB in Methuen, Exit 47 SB in Methuen, Exit 51 SB in Haverhill, and the eastbound merge of I-495 into I-95 in Salisbury. The 5 diverge movements operating at LOS F will be at Exit 41 SB in Andover, Exit 43 SB in North Andover, Exit 45 SB in Lawrence, Exit 46 SB in Methuen, and Exit 50 SB in Methuen. The one weave at LOS F will be located in the westbound direction between Exits 48 and 47.

Of particular note is that all of the merge/diverge/weave movements that are predicted to operate with LOS F conditions are, with only one exception, located at points along the westbound direction of the I-495 highway. Again, this reflects the very heavy predominance of traffic flow in the westbound direction on this section of the highway during the AM peak hour. The one exception in the eastbound direction during this time period will be, as noted above, the merge of I-495 NB with I-95 NB in Salisbury.

<u>PM Peak Hour</u>

Results of the analyses performed with regard to merge/diverge/weave movements for the 2030 PM peak hour are summarized graphically on Figures 3-13 and 3-14 for the Western Segment and the Eastern Segment of I-495, respectively.

Looking first at the Western Segment as illustrated on Figure 3-13, analyses show that, of the 38 merge/diverge/weave movements examined, 21 movements (55 percent) will operate in the desirable LOS A through LOS D range, compared with 32 movements (84 percent) in 2006. The remaining 17 locations (45 percent) will operate at either LOS E or LOS F levels. In this particular case, two movements, a merge at Exit 38 SB in Tewksbury and a weave at Exit 40 NB in Andover, will experience LOS E conditions. The remaining 15 movements at LOS F include 6 merges, 5 diverges, and 4 weaves, the locations of which can be clearly seen on Figure 3-13.

As Figure 3-13 illustrates, the majority of merge/diverge/weave movements predicted to operate at LOS E or LOS F levels are located on the westbound direction of the I-495 highway. This situation is the

opposite of the AM peak hour experience but, again, is entirely reflective of the higher traffic flows in this direction during the PM peak hour.

Conditions in the Eastern Segment of the study corridor with regard to merges, diverges, and weaves are illustrated in graphical form on Figure 3-14. Analyses have determined that the number of movements that will operate in the desirable LOS A through LOS D range during the PM peak hour in the Eastern Segment will be 52, representing 83 percent of the 65 merge/diverge/weave movements that were examined. For 2006, a total of 63 movements (97 percent) were determined to be operating in the desirable LOS A through LOS D range. In 2030, three movements (5 percent), two diverges and one weave, will experience LOS E conditions while eight movements (12 percent), three merges, three diverges, and two weaves will operate at LOS F. The two diverge movements that will operate at LOS E in 2030 will be located at Exit 47 NB in Methuen and Exit 50 NB in Haverhill, while the one weave movement at LOS E will also be at Exit 50 in Haverhill. The LOS F locations will be three merges at Exit 45 in Lawrence, Exit 47 in Methuen, and Exit 48 in Haverhill; three diverges at Exit 43 in North Andover, Exit 48 in Haverhill, and Exit 49 in Haverhill; and two weaves at Exit 45 in Lawrence and Exit 46 in Methuen.

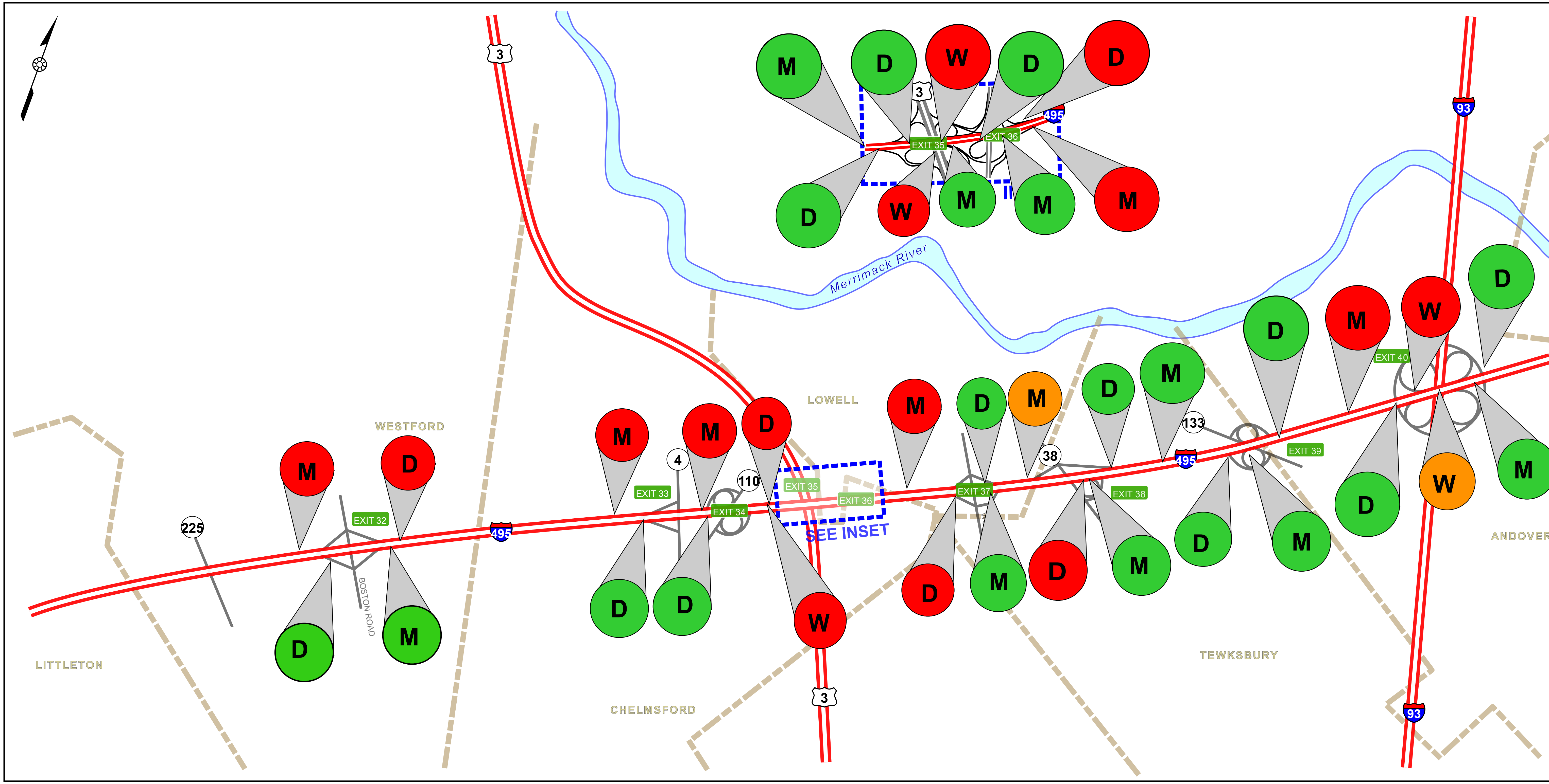
The PM peak hour in the Eastern Segment is also particularly noteworthy with regard to the locations where merge/diverge/weave locations will operate at LOS E or LOS F. Again, all such movements, with the exception of the diverge movement from I-95 SB to I-495 SB in Salisbury, will be located in the eastbound direction of I-495 and all concentrated in the area between Exit 43 in North Andover and Exit 50 in Haverhill. The eastbound direction is the predominant flow of traffic in the PM peak hour in the Eastern Segment of the study corridor.

Links

Another key aspect of the analysis of Future 2030 No-Build conditions was the analysis of link levels of service along I-495 for the length of the study corridor. As with the analyses of intersections and merge/diverge/weave movements, the analyses of link levels of service are discussed here in briefly and illustrated graphically in accompanying Figures.

<u>AM Peak Hour</u>

On Figure 3-15 can be seen the graphical presentation of the link level of service analysis conducted for the Western Segment of the study corridor during the AM peak hour. Figure 3-15 shows a total of 18 link locations where LOS analyses were undertaken. As can be seen, only seven links



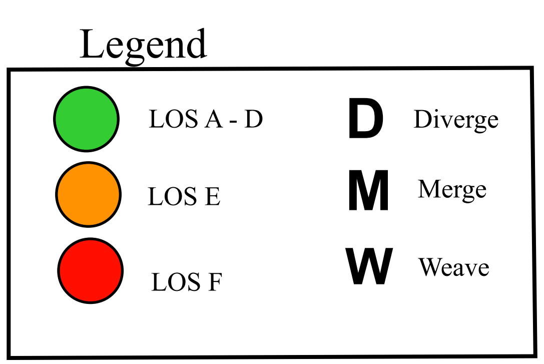


Figure 3-13*
2030 PM Peak Hour Ramp Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

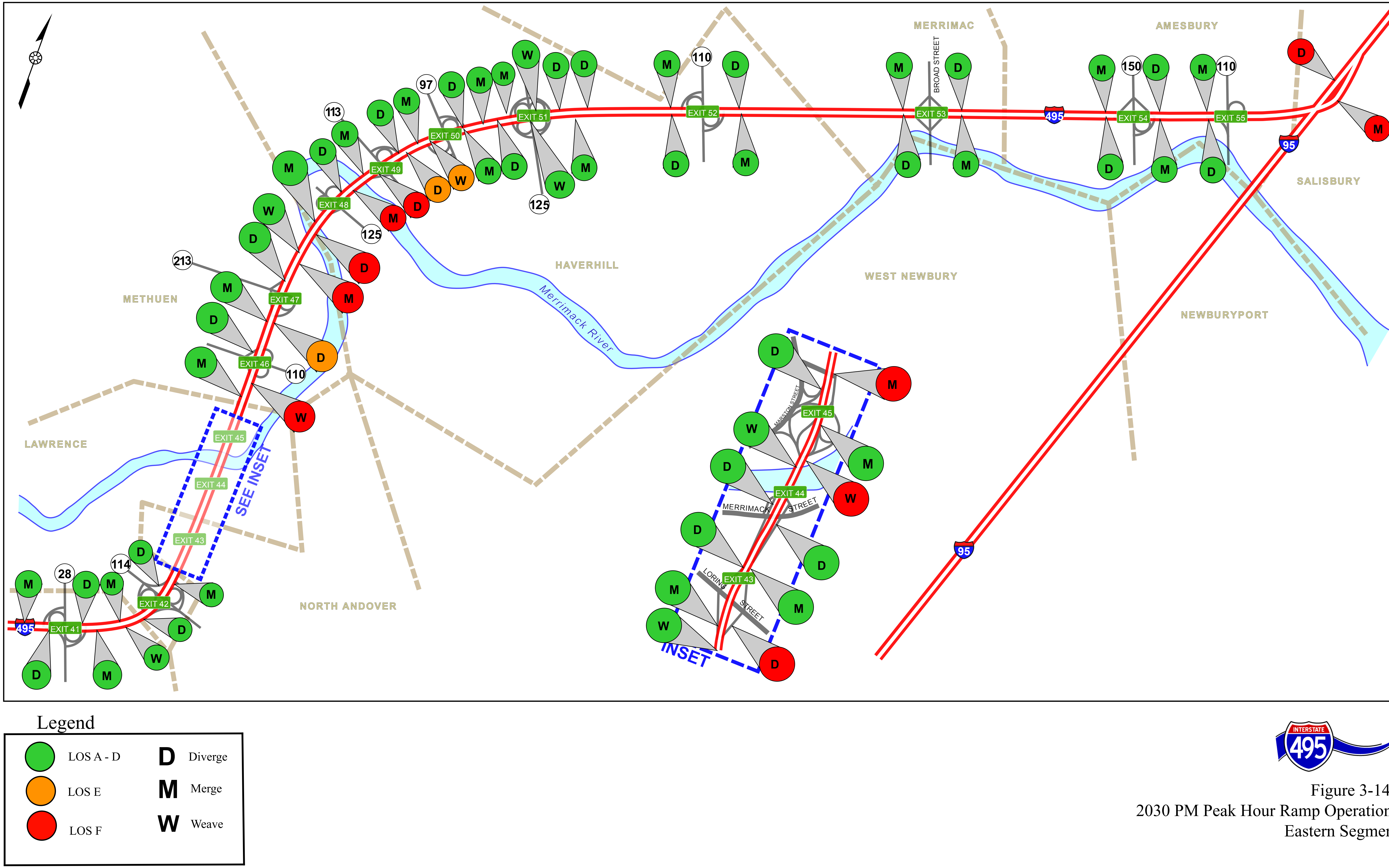
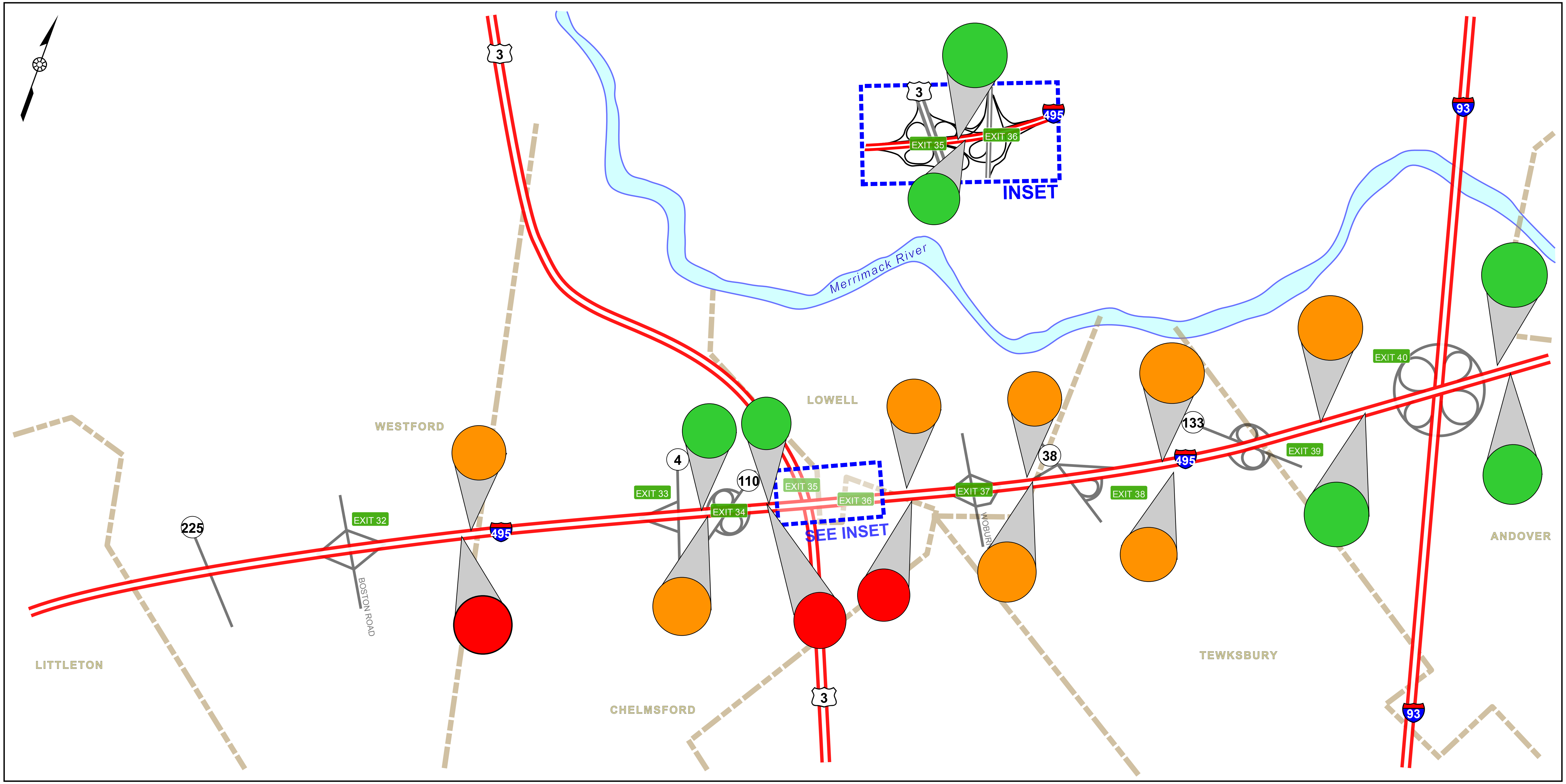


Figure 3-14*
2030 PM Peak Hour Ramp Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

- LOS A - D
- LOS E
- LOS F

Figure 3-15*
2030 AM Peak Hour Link Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

(39 percent) were predicted to operate in the desirable LOS A through LOS D range during the 2030 AM peak hour. Four of these seven locations were determined to be in the westbound direction, the direction which experiences less traffic during the AM peak than does the eastbound direction. Eight links (44 percent) were determined to operate at LOS E while the remaining three (17 percent) will see LOS F conditions.

Similar to the results presented in the section above regarding merges, diverges, and weaves, it is of interest to note that all of the links in the Western Segment that are predicted to operate at LOS F are located in the eastbound direction of the highway, once again reflecting the heavier volumes of traffic in this direction during the AM peak.

Figure 3-16 graphically presents AM peak hour link level of service determinations for the Eastern Segment of the study corridor. In the Eastern Segment, a total of 30 links was evaluated, 15 in each direction. Of the 30 links, 22 links (74 percent) will operate in the desirable LOS A through LOS D range. Of note is that all 15 links analyzed in the eastbound direction will be in this group. Of the remaining links out of the total of 30 analyzed, 4 links (13 percent) will see LOS E conditions and 4 links (13 percent) will operate at LOS F. Those link locations that will see LOS E or LOS F conditions are all located between Exit 50 in Haverhill and Exit 41 in Andover. Again, these links are all located on the side of I-495 in the Eastern Segment that sees the greatest volume of traffic during the AM peak hour, namely the westbound direction.

PM Peak Hour

On Figure 3-17 can be seen the results of the 2030 link level of service analysis for the PM peak hour in the Western Segment. Of the 18 links analyzed, 10 links (56 percent) will operate in the desirable LOS A through LOS D range. Of the remaining links, five links (28 percent) will operate at LOS E and three links (16 percent) will operate at LOS F. Note that all three links predicted to operate at LOS F are located in the westbound direction, where traffic flow in the PM peak is greater than that in the eastbound direction.

The final Figure in this series, Figure 3-18, graphically illustrates the results of the link level of service analysis for the Eastern Segment of the study corridor for the 2030 PM peak hour. Of the 30 locations analyzed, it was determined that 23 links (77 percent) will operate in the LOS A through LOS D range. All links in the westbound direction are included in this category. In the eastbound direction, there will be three links (10 percent) at LOS E and four links (13 percent) at LOS F. As with other examples noted previously in this section, the LOS E and LOS F conditions in the eastbound direction are directly related to the heavier

volumes of traffic that will be traveling in this direction during the PM peak hour.

3.2.1.3 Crashes

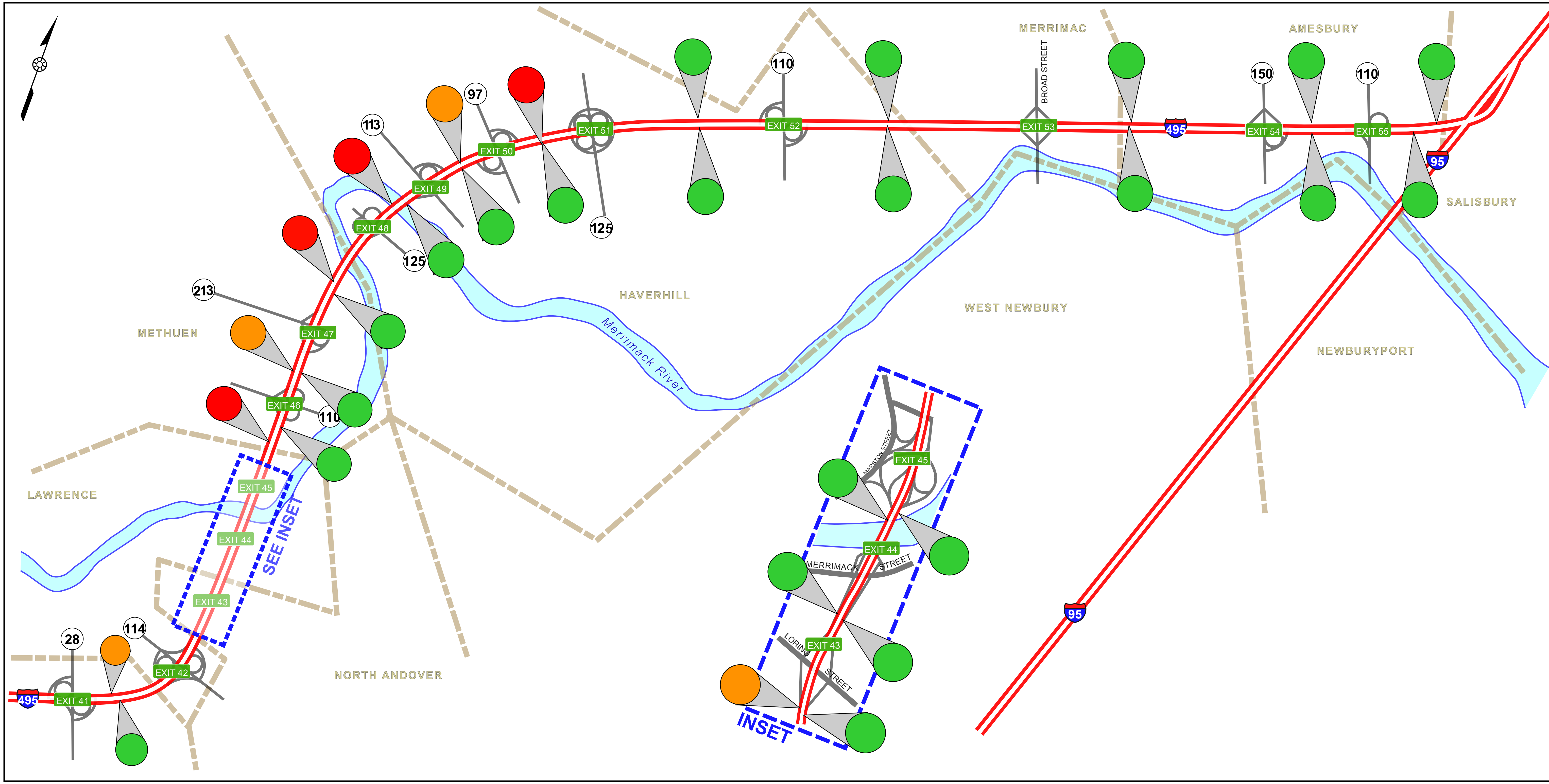
Studies and analyses undertaken throughout the country have revealed that there is a direct correlation between traffic volumes and the number of crashes that occur. As traffic volumes increase, so too do the number of crashes. The I-495 corridor, including the highway itself and its interchanges, have been determined to follow this nationwide pattern. There is no reason to assume that they will not continue to do so in the future. Accordingly, by 2030, the future year with regard to this study's traffic analyses, the number of crashes that can be expected to occur can reasonably be assumed to rise in some proportion to projected increases in traffic volumes.

As noted elsewhere, volumes on I-495 are typically greater on the western end of the study corridor than on the eastern end of the corridor and will continue to be so in the future. Therefore, one can expect that the greatest number of crashes in the future will continue to occur at these same locations. In addition, Exits 32 in Westford, 35 in Chelmsford, 40 in Andover, and 51 in Haverhill will likely continue to experience the highest number of crashes of all the interchanges along I-495, as they do now.

Attempting to predict the actual number of crashes that will occur is far from an exact science. Nevertheless, one can reasonably conclude that there will be more crashes in the future along the corridor than there are today.

3.2.1.4 Future Transportation/Transit Improvements

Future transportation/transit improvements that relate to the study area have been identified in previous planning studies and documents. However, the majority of the improvements relate to the north-south mobility, specifically the transit and highway connections to New Hampshire as noted in the *I-93 Corridor Study*. One key recommendation of this study is for the MBTA to restore double trackage between Haverhill and Lawrence on the Haverhill commuter rail line so that more service could be offered, service that would have the potential for removing traffic from I-495. In addition, the MBTA, in cooperation with the Nashua Regional Planning Commission, is seeking to restore rail service from Manchester and Nashua to Lowell connecting the MBTA commuter rail service to Boston. This service could be operated by the MBTA as an extension service from Lowell and include a stop in North Chelmsford. The MBTA is also considering new express bus service from Lowell to the Hanscom Field/Hanscom Air Force Base area.



Legend

- LOS A - D
- LOS E
- LOS F

Figure 3-16*
2030 AM Peak Hour Link Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

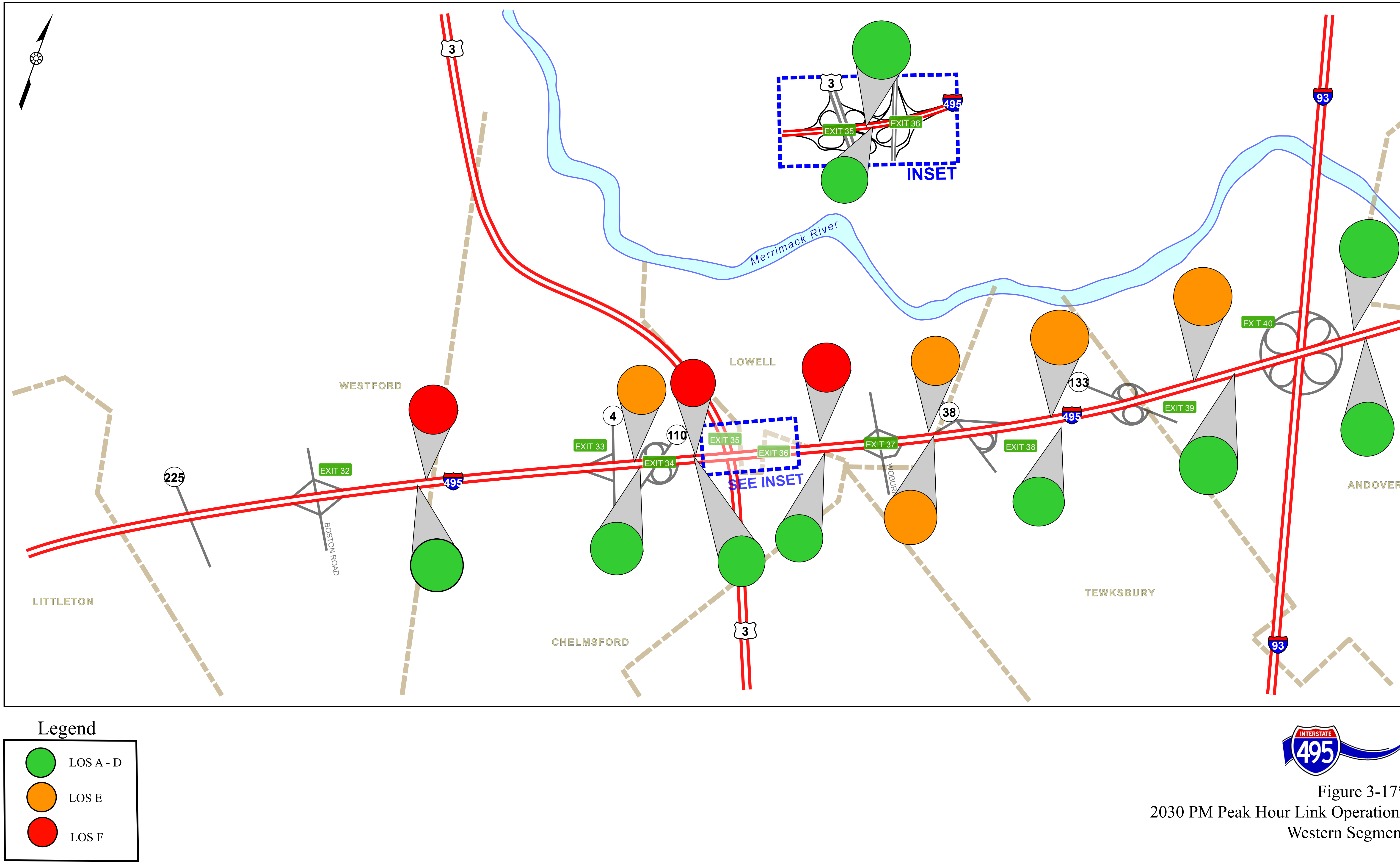
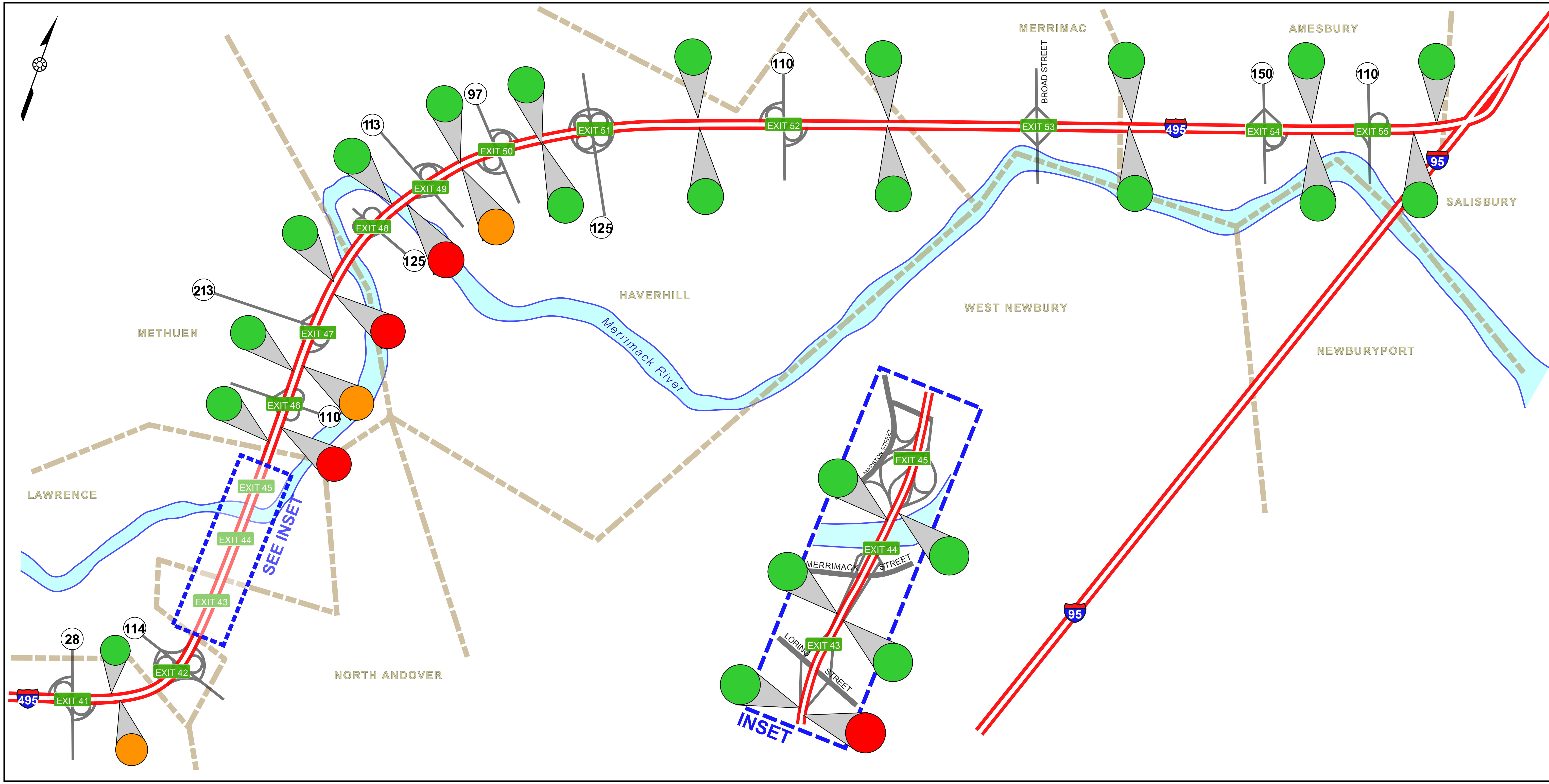


Figure 3-17*
2030 PM Peak Hour Link Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Enegry and Environmental Affairs



Legend

- LOS A - D
- LOS E
- LOS F

Figure 3-18*
2030 PM Peak Hour Link Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

Additional recommendations were obtained from the Merrimack Valley Metropolitan Planning Organization FY 2008-2011 *Transportation Improvement Program*.

Transit projects within the Merrimack Valley Metropolitan Planning Organization FY 2008-2011 *Transportation Improvement Program* include:

Highway High Priority Projects (HPP) –

- Amesbury-Newburyport – Rehabilitation of I-95 Whittier Bridge;
- Andover – Design, Engineering and Construction at I-93 The Junction Interchange,
- (Andover, Tewksbury, and Wilmington);
- Haverhill – Construct Haverhill intermodal center access and vehicle capacity improvements;
- Lawrence – Design and construct Canal and Union Street Corridor improvements;
- Lawrence – Construct access improvements to the Lawrence Gateway Project;
- Methuen – Design, engineering and construction of Methuen Rotary alternative at I—93 and State Routes 110 and 113;
- Newbury – Rehabilitation and paving of Parker River Road;
- North Andover – Improvements to Mass. Ave., Andover St., Osgood St., Salem St. and Johnson Street in the Old Town Center of North Andover; and
- Salisbury to Danvers – Design, Engineer, Permit and Construct "Border to Boston Bikeway" rails-to-trails project.

Transit Projects for Bus and Bus-Related Facilities and Clean Fuels Grant Program-

- Haverhill – Design and Construct Intermodal Transit Parking Improvements;
- Newburyport – Design and Construct Intermodal Facility; and
- Lawrence – Gateway Intermodal and Quadrant Area Reuse.

3.2.2 Land Use

Section 2.3.2 in Chapter 2 provided discussions of existing land use within a one-mile radius of the various I-495 interchanges along the study corridor, specifically noting the dense urban development of the traditional mill cities of Lowell, Lawrence, and Haverhill and the contrasting low-density suburban development typical of many of the corridor communities. Within these discussions for several of the communities

were references to undeveloped land, the key locations of which are summarized here. It is likely that much of this undeveloped land will be developed in future years, one result of which will be additional traffic on I-495 generated by the new uses. Assumptions of future growth in these areas were incorporated into the CTPS traffic model that was used to project future traffic volumes on roadways in the study corridor.

In Westford in the study corridor's Western Segment, it was noted that there are approximately 200 acres of industrially zoned land in the vicinity of Exit 32 available for development. An area of vacant land near Exit 35 in Chelmsford is also zoned for industrial development, but environmental issues associated with this land may limit its future development potential. In Lowell, the area of greatest future development potential was noted to be CrossPoint. Large areas of forested and industrially zoned land were described for locations in Tewksbury near the I-495 interchanges.

For Lawrence in the study corridor's Eastern Segment, several old mill buildings being redeveloped into other land uses were noted, as were areas of forested land near the city's interchanges. A large 50-acre tract of undeveloped land in Methuen near Exit 47 and zoned for commercial development was specifically cited. Other industrial land and forested land in the vicinity of this same Exit were also referenced. Near Exit 48 in Haverhill is another large area of undeveloped land offering the potential for a substantial amount of future development. Another large industrially zoned area of land near Exit 50 in Haverhill exists, but its development potential may be limited because of environmental issues. Similar land also exists near Exit 52 in Haverhill. Several large tracts of undeveloped land can be found near Exit 54 in Amesbury.

During the course of preparation of this corridor study, a number of specific development projects that have already entered the environmental impact review process and/or have received required permits were identified and taken into consideration. Among these projects were the following:

Again, these developments and others, as they are approved and constructed, will all result in additional traffic being placed on I-495. Traffic volumes likely to be associated with these known future developments were specifically added to projections of future traffic in the study area produced by CTPS. Other possible developments that, if they come to fruition will generate additional traffic, including the Brickstone/Shawsheen Square development at Exit 41 and the Golden Triangle development at Exit 55, have not been specifically included in the traffic analysis.

Name	Town	Near	Units
1. Westford Technology Park East	Westford	Exit 32	Office (400,000 sf)
2. Westford Technology Park East	Westford	Exit 32	Pharmacy (15,000 sf)
3. Westford Technology Park East	Westford	Exit 32	Retail (7,500 sf)
4. Primrose Park	Westford	Exit 32	Office (24,000 sf)
5. Westford Elderly Housing	Westford	Exit 32	Residential (36 units)
6. Tadmuck Meadow	Westford	Exit 32	Residential (41 units)
7. Westford Technology Park West	Westford	Exit 32	Office (800,000 sf)
8. Southgate	Westford	Exit 32	Residential (42 units)
9. Home Improvement Store	Lowell	Exit 36	Retail (155,000 sf)
10. Lawrence High School	Lawrence	Exit 42	School
11. Village at Russell Farm	Methuen	Exit 47	Residential (157 units) Office (16,000 sf) Retail (8,000 sf)
12. BJ's Wholesale Club	Haverhill	Exit 48	Retail
13. Northgate Retail Plaza	Haverhill	Exit 50	Retail

3.2.3 Socio-Economics

Projections of future socio-economic conditions in the I-495 study area corridor with regard to population, households, and employment, were presented and discussed in detail on a community-by-community basis in Section 2.3.3 of Chapter 2 in association with a presentation and discussion of existing socio-economic characteristics. The projections used were those developed by the Northern Middlesex Council of Governments and the Merrimack Valley Planning Commission, the two regional planning agencies serving the communities along the I-495 study corridor.

Population in the study area communities was projected to increase by 16 percent by the year 2030 in comparison with year 2000 population. The number of households was projected to increase by 21 percent during this same time period, and employment was projected to increase by 20 percent.

3.3 Summary of Future Conditions/Issues

Traffic Volumes

- Traffic volumes along the corridor will have grown since existing conditions, but at smaller rates than have been experienced in the past.

- Average weekday daily traffic volumes on I-495 will range from 146,400 vehicles per day at the far western end of the corridor in Westford to 62,000 vehicles per day at the eastern end of the corridor in Amesbury.

- During the AM peak hour in the eastbound direction, volumes will range from 6,610 vehicles in Westford to 1,880 in Amesbury. In the opposite westbound direction, they will range from 2,450 vehicles in Amesbury to 5,890 in Westford. In the eastbound direction during the PM peak hour, traffic volumes are projected to range from 5,250 vehicles in Westford to 2,340 in Amesbury. In the westbound direction, they will range from 2,230 in Amesbury to 6,400 in Westford.

Traffic Analyses

As was done for the study of existing traffic issues presented in Chapter 2, the analysis of future 2030 No-Build conditions also divided the I-495 study corridor into a Western Segment and an Eastern Segment.

Similarly, future 2030 No-Build traffic conditions were examined from the perspective of (1) signalized and unsignalized intersections, (2) merge, diverge, and weave movements, and (3) highway links between interchanges. In each case, level of service determinations were made to determine how well the I-495 highway system would be expected to be performing in the year 2030, assuming no specific physical changes to that system other than those already being planned independent of this study.

Key results of the analyses of future 2030 No-Build conditions are summarized below:

Intersections

- In the Western Segment of the study area in the AM peak hour, all six signalized intersections (100 percent) will continue to operate at LOS D or better in 2030. However, the percentage of individual movements within these intersections operating at LOS D or better will decrease from 95 percent in 2006 to 91 percent in 2030. For unsignalized intersections, the percentage of individual movements within them operating at LOS D or better will decrease from 87 percent in 2006 to only 70 percent in 2030.

- For the Eastern Segment in the AM peak hour, the seven signalized intersections (100 percent) will operate with LOS D or better conditions in 2030. And, 43 out of 44 individual movements (98 percent) within the signalized intersections will operate at LOS D or better in 2030. With regard to unsignalized intersections, the percentage of individual movements that operate at LOS D or better will be 94 percent.

- During the PM peak hour in the Western Segment, all six signalized intersections will continue in 2030 to operate at LOS D or better overall. However, the percentage of individual movements within these signalized intersections operating at LOS D or better will decrease slightly from 89 percent in 2006 to 86 percent in 2030. There will also be a similar decrease, from 78 percent in 2006 to 74 percent in 2030 for the individual movements at the unsignalized intersections in the Western Segment.

- For the Eastern Segment during the PM peak hour, there will for the first time be a signalized intersection that will operate at LOS F overall, although the other six signalized intersections will operate at LOS D or better. It was determined that, with regard to individual movements within unsignalized intersections, 85 percent will operate at LOS D or better.

Merges, Diverges, and Weaves

- In the Western Segment during the AM peak hour, 66 percent of these types of movements will operate at LOS D or better in 2030, compared with 89 percent in 2006. Similarly, in the Eastern Segment during the AM peak hour, 83 percent of these typed of movements will operate at LOS D or better, compared with 94 percent in 2006.

- For the PM peak hour in the Western Segment, only 55 percent of these movements will operate at LOS D or better. The percentage in 2006 was 84 percent. In the Eastern Segment, the percentage will decline from 97 percent in 2006 to 83 percent in 2030.

Links

- By 2030 in the Western Segment of the study corridor, only 39 percent of I-495's links will operate with LOS D or better conditions during the AM peak hour. The corresponding value in the Eastern Segment of the study corridor during the AM peak hour will be 74 percent. All (100 percent) of these links currently in 2006 operate at LOS D or better. For the PM peak hour in the

Western Segment, only 56 percent of I-495's links will operate at LOS D or better, with the percentage being 77 percent in the Eastern Segment. Again, all (100 percent) of these links presently operate at LOS D or better in 2006.

Conclusions

It is clear from the information presented in this chapter that conditions along I-495 will deteriorate from what they are today to what they are projected to be under the assumed 2030 No-Build case. That is, the projected increases in traffic volumes on the I-495 highway system resulting from population growth, changes in land use, increases in employment, etc. will put strains on the ability of that highway system to accommodate the increased demands being placed on it.

Impacts of the projected increases in traffic volumes have been identified with regard to signalized and unsignalized intersections located at the points where the highway's ramps connect with the local street system; at merge, diverge, and weave locations at or near the highway's interchanges; and on the mainline highway itself.

The vast majority of the identified impacts of the projected increases in traffic by 2030 will be located along that portion of the study corridor between Exit 32 in Westford and Exit 50 in Haverhill.

Chapter 4 presents a program of improvements that has been developed to address the deficiencies identified in this Chapter, as well as those identified in Chapter 2 and from the public involvement process. The improvements are categorized as being suitable for implementation in the near term (less than 2 years), mid term (2 to 8 years), and long term (more than years).

Other Transportation/Transit Improvements

More than one dozen potential future transportation projects by others have been identified in this chapter. They range from roadway improvements to extension and improvement of commuter rail services.

4.0 Recommended Improvements Plan

4.1 Introduction

The primary focus of this chapter is a presentation and discussion of potential improvements that could be implemented within the I-495 corridor, both along the highway itself and at its interchanges with cross streets. These potential improvements have been developed in response to the traffic operational deficiencies identified in both Chapter 2 and Chapter 3 and from public input received from the Study Advisory Group, public informational meetings, and comments made on the project's web site. The potential improvements also address safety issues. They are categorized for potentially being implemented in the near term, mid term, or long term.

Near-term improvements can generally be described as being relatively simple in nature, inexpensive, and able to be implemented quickly. Implementation times are typically less than two years. Examples of such improvements might include pavement re-striping to create additional travel lanes and timing changes to existing traffic signal systems. These types of improvements most often involve work at intersections.

Mid-term improvements are more complicated and expensive to plan, design, and put into service. They sometimes involve limited amounts of property acquisition and typically take two to eight years to implement. Installing a traffic signal system at an intersection currently without one is one example of a mid-term improvement project. Lengthening acceleration and decelerations on a highway to conform to existing standards is another example of this type of improvement. Reconfiguring an intersection to widen approaches and to add dedicated turning lanes is yet another example of a mid-term project.

Long-term improvements are characterized by requiring timeframes of longer than eight years for their implementation. They can be the most complicated and costly to design and construct, and often require extensive environmental review. Substantial property acquisition may be involved, but not necessarily so. Examples of such types of long-term improvements include the provision of additional travel lanes on a mainline highway (thus increasing its capacity), reconstructing the ramp system at an interchange to interface with a widened mainline highway, the construction of a new interchange along a highway, etc. These types of long-term improvements all substantially alter operations on and/or

access to/from the mainline. It should also be recognized that this study's horizon year was 2030. As traffic continues to grow beyond that point, additional improvements beyond those discussed in this document will likely be required.

Before discussing potential short-term, mid-term, and long-term improvements to the I-495 infrastructure, including its interchanges with the local roadway system at the 25 interchanges located along the study area corridor, this chapter first presents conclusions regarding the ability of means other than these types of physical changes to the roadway system to help address the deficiencies identified in Chapter 2 and Chapter 3 and from the public input process employed for this study. The key purpose of these latter types of actions is to reduce travel demands on the roadway system, not to physically increase the system's capacity. If successful, they would reduce the need for, or at least delay the need for, physical improvements to that system. While not meant to be stand-alone solutions, they all provide a positive contribution towards addressing area transportation needs.

The improvements discussed here are only potential solutions to existing and future problems that have been identified during the course of this particular study. They have been presented to the Study Advisory Group and to both the Merrimack Valley Planning Commission and the Northern Middlesex Council of Governments for their review and consideration at s series of meetings. It will be the responsibilities of these two agencies and the communities in which the potential projects are located to move them through the "3C" planning process and to have them added to the regions' Transportation Improvement Program (TIP) and Long Range Transportation Plan, as appropriate, for implementation in the future, as discussed in more detail at the end of this Chapter.

4.2 Non-Highway Capacity Enhancing Strategies

This section examines the potential effectiveness of several strategies for reducing traffic demands on I-495. They do not involve direct construction of physical improvements having the purpose of increasing the roadway system's capacity. Rather, these strategies involve promoting land uses that reduce future trip generation, the provision of Park & Ride lots to reduce traffic volumes by means of travelers sharing vehicles, and the implementation of improvements to the region's public transportation system that would result in individuals switching modes from private automobile to public transportation. Each strategy is discussed in the sections that follow.

4.2.1 Land Use/Trip Generation

Vehicle trips on all roadways are a result of land use. In and of themselves, roadways do not create vehicle trips. Rather, as documented in the Institute of Transportation Engineers' Trip Generation, 7th Edition, it is land use that generates vehicle trips. Additionally, different types of land use generate different amounts of vehicle trips. For example, based on Trip Generation data, an average office-type land use generates 11.01 vehicle trips per 1,000 square feet on a typical weekday compared with a large discount retail development that generates 56.02 vehicle trips per day per 1,000 square feet. On an hourly basis, the average office building generates 1.55 trips per 1,000 square feet during the AM peak hour and 1.49 vehicle trips per 1,000 square feet during the PM peak hour. The large discount retail store, on the other hand, generates only 0.84 vehicle trips per 1,000 square feet during the AM peak hour but 5.06 vehicle trips per 1,000 square feet during the PM peak hour. Consequently, if the trip generation characteristics of various land uses were reviewed and their ultimate impact on I-495 peak hour operations understood, it could be that promoting a mix of lower-trip-generating land uses rather than higher-trip-generating land uses could result in fewer future trips on I-495. The goal of such an approach toward lowering future trips would be to maximize the useful life of I-495's existing capacity and, in so doing, local operations on local roads would also benefit. Theoretically, if a sufficient amount of future trip generation could be avoided, the very large amounts of funding needed to widen I-495 could potentially be delayed and less-congested operations could occur for a longer period of time.

To understand the potential contribution that this approach could make to future operations, CTPS extracted from its regional model data pertaining to the total vehicle trips generated in the 13 communities that encompass this study's I-495 corridor and then subdivided these data into various components, as discussed in the following text.

As illustrated on Figure 4-1a, there are approximately 234,900 vehicle trips generated by corridor communities during the 2006 three-hour AM peak period. The majority of these trips (58 percent) both begin and end within one of the corridor's 13 communities. The remaining 42 percent either begin or end within a corridor community.

Figure 4-1b illustrates that within the 2006 three-hour AM peak period there are 91,800 vehicles traveling somewhere on the 40-mile section of I-495 within the study area. With over 234,000 vehicle trips generated within corridor communities, and only 91,000 vehicles traveling on I-495 at the time of that generation, it appears that the vast majority of corridor-

generated trips are not utilizing I-495. This conclusion is documented by Figure 4-1b.

Based on the data summarized in Figure 4-1b, 51 percent of all I-495 trips during the 2006 AM peak period are totally unrelated to corridor points of origin or destination. These are trips that utilize I-495 as a link in a longer trip that begins and ends outside any of this study's 13 corridor communities.

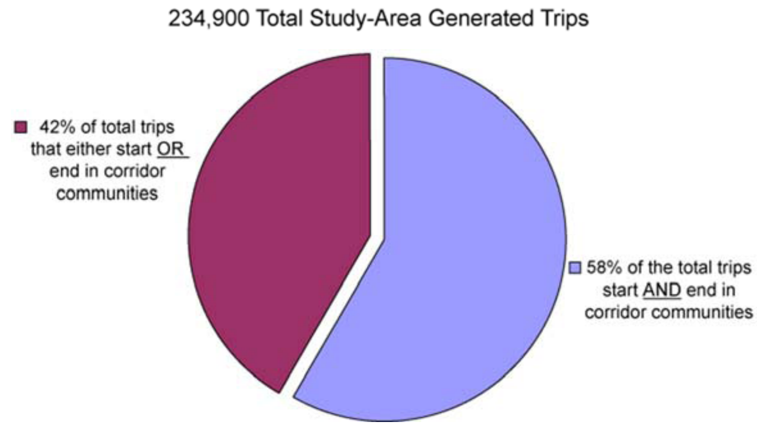
This relationship of corridor trip generation and I-495 travel is summarized on Figure 4-1c. Of the 234,900 trips generated during the AM peak period, only 19 percent involve I-495 as part of their travel route. Consequently, 81 percent of the existing trips generated within the corridor's 13 communities do not rely on I-495 at all.

The goal of prolonging I-495's useful life by reducing trip generation must be based on influencing future trip generation. Based on CTPS projections for 2030, it is anticipated that there will be an additional 8,700 vehicles traveling on the I-495 corridor during the three-hour AM peak period.

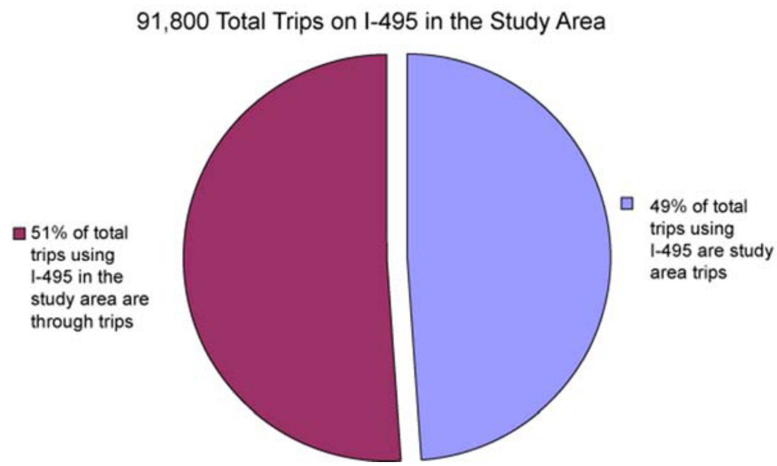
However, as discussed in Chapter 2, traffic operations are calculated for a single peak hour. So, to understand the potential impact to I-495 future operations, this three-hour total is reduced from 8,700 vehicles to 2,900 vehicles. Then, because that total represents travel in both directions, for purposes of this example, this volume is divided in half, to 1,450 vehicles per direction. This volume is occurring across the 40-mile corridor so that within a given mile there may only be an additional 36 vehicles. Within that mile, there are three lanes (with the exception of east of Exit 55 where there are two travel lanes) and, thus, in the future if no alteration of projected corridor-generated land use occurs, there will be an additional 12 vehicles per lane mile. It is clear that such a reduction is not enough to negate the potential need for widening long portions of I-495 and for making improvements to many of its intersections with the local street system.

The preceding is a generalized example and there will be sections of I-495 recording a larger than average amount of future traffic volumes growth. Still, even reducing future corridor trip generation by half would not meaningfully prolong acceptable peak hour operations on I-495.

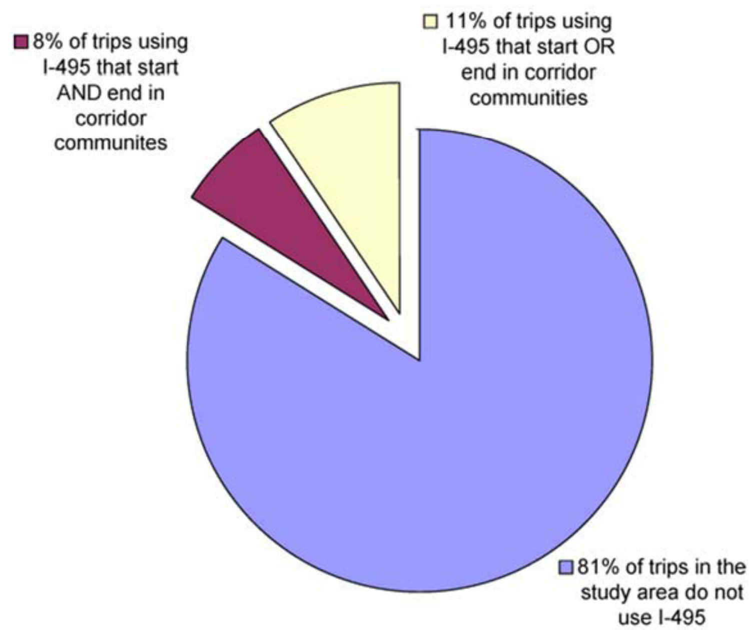
Total Trips Generated by Corridor Communities



Total Trips on I-495 in the Study Area - 2006 Three-Hour AM Peak Period



Total Trips Generated by Corridor Communities 2006 AM Three-Hour Peak Period



Figures 4-1a – 4-1c
Total Trips Generated by Corridor Communities
Total Trips on I-495 in Study Area

This is not to suggest that corridor communities should eliminate land use and its associated trip generation from consideration. At specific interchange locations where large trip-generating land uses are proposed, the most focused impact of those new trips on a specific interchange and its related merge and diverge movements on I-495 should be considered. It is most likely that as a strategy for prolonging I-495's ability to provide acceptable operations, modulating trip generation will be most beneficial at the individual interchange level where the direct impacts of new trips are most concentrated.

Additionally, as communities review proposed developments they could review with project proponents the contributions to reducing vehicle trip making that incorporating transportation demand management measures can achieve. These measures would be most effective in office and industrial type developments. Such land uses tend to have large numbers of people working similar hours, thus increasing the likelihood of being able to match workers into carpool arrangements. Further, for all development projects, noting proximity to existing or proposed bicycle routes, pedestrian paths, and transit routes and incorporating or at least not precluding appropriate project connections to these transportation amenities is also worth consideration.

4.2.2 Public Transportation Improvements

Another strategy for reducing the number of peak hour vehicles on I-495 could involve shifting drivers out of cars and onto transit.

Unfortunately, the ability of public transit to address traffic demands on I-495 is limited due to the multiple trip origins and destinations within the study area. Only 19 percent (44,800 trips) of the 234,900 trips[1] that begin or end within the corridor study area communities use I-495. These trips represent only half of total trips on I-495 within the study area. Of the total 91,800 trips on I-495, 47,000 (51 percent) are through trips using the Interstate for longer distance travel.

Unlike the I-93 corridor, which provides commuter access to the dense concentration of jobs found in Boston, an example of many origins to one ultimate destination, employment along I-495 is dispersed along the corridor – many origins to many destinations. This many-to-many pattern is not conducive to transit trip making because its dispersed origins and destinations are contrary to the geographically concentrated locations of riders and their destinations needed to facilitate time and cost efficient transit travel.

[1] 2006 3-hr AM peak trips provided by CTPS. See Section 4.2.1 for additional discussion.

Commercial and industrial land uses are located within the historic city downtowns of the Merrimack Valley or along state highways with access to I-495. The U.S. Route 3 and I-93 corridors, in particular, contain a large concentration of industrial land uses.

Public transit is most effective where there are concentrations of employment and housing along a defined travel corridor. Existing transit service within the study area centers on the older industrial cities of the Merrimack Valley--Lowell, Lawrence, and Haverhill--with bus service radiating into adjacent communities. None of the Lowell Regional Transit Authority (LRTA) or Merrimack Valley Regional Transit Authority (MVRTA) bus routes operates on I-495. It is expected that the current travel patterns and transit usage within the study area will continue, with the providers focused primarily on serving the traditional urban areas of the Merrimack Valley.

Future transit improvements identified in previous planning studies relate more to the north-south mobility between New Hampshire and Boston, than to the east-west travel within the I-495 corridor between Westford and Salisbury. The effectiveness of public transportation in capturing large number of people traveling from one dense area to another is illustrated by the fact that approximately half of the boarding on the Lowell and Haverhill commuter rail lines to Boston occur at stations within those two Merrimack Valley communities. The Nashua Regional Planning Commission, in cooperation with the MBTA, has proposed to restore rail service from Manchester and Nashua to Lowell connecting to MBTA commuter rail service to Boston. The Merrimack Valley Metropolitan Planning Organization is seeking to increase service along the MBTA's Haverhill commuter rail line by adding a second track. While this improvement is primarily aimed at increasing the number of trains to Boston, the MBTA Haverhill line provides access between Haverhill and Lawrence. The provision of a second track would allow increased service between these two I-495 corridor communities also. Such improvements are very unlikely to offset the need for improvements to I-495.

Consequently, as a stand-alone solution, transit cannot eliminate the numbers of trips needed to avoid the future need to add capacity to I-495. However, this is not to say that transit plays no part in reducing travel demand on I-495 today and in the future. Total peak hour trips on I-495 are lower today due to transit than would be the case without transit. Thus, while not a stand-alone solution, transit makes a contribution to operations on I-495.

4.2.3 Park & Ride Lots

As discussed in the following text, while formalized transit on fixed routes does not lend itself to the nature of this corridor, carpooling can in fact meet the dispersed nature of corridor travel and provide a viable alternative to total reliance on single occupancy vehicles. A system of Park & Ride lots would allow commuters an alternative travel mode and contribute to reducing peak hour travel on I-495. While perhaps not a stand-alone solution to future congestion, Park & Ride lots offer commuters an opportunity to reduce fuel consumption, decrease air pollution, and extend the life of vehicles.

Existing transportation management associations (TMAs), such as the Junction TMO and the Merrimack Valley TMA, along with MassRides, are currently in operation with the mission to work with commuters and employers to facilitate carpool formation. In essence, the software for forming carpools exists, it is the hardware or the physical Park & Ride lot locations that need to be developed.

The locations of three existing Park & Ride lots in the study area were identified in Chapter 2. None of these lots are directly along the I-495 corridor and all generally serve commuters traveling in a north/south direction oriented toward Boston. Two of the lots are served by public transportation. The capacities of these existing lots vary but are generally in the 100 to 200-vehicle range.

Park & Ride lots serve as locations where drivers can leave their vehicles for a period of time, continuing on to their destinations by some other means. These means may include the use of public transportation modes that serve the Park & Ride lots or, alternatively, being picked up by another privately owned vehicle in some type of ride-sharing arrangement. In either case, the result is fewer single-occupancy vehicles on the roadway network for at least part of involved trips. To the extent that additional such lots can be established, the more that traffic demand on the regional highway network, particularly I-495 itself, can theoretically be reduced.

As part of the study effort, a search for potential additional Park & Ride locations in the study corridor was undertaken. A key criterion was that the locations would have to be adjacent to or reasonably close to the I-495 corridor. Three such potential locations were identified and are briefly discussed in the following text. It must be emphasized that the locations are privately owned and no attempt has been made to contact the owners about availability of the property involved.

One potential Park & Ride site is located in Tewksbury off State Route 133 at I-495's Exit 39, directly adjacent to the northbound ramps. The potential site is currently heavily wooded vacant land, as shown on Figure 4-2a. This site is located in the Western Segment of the I-495 study corridor.

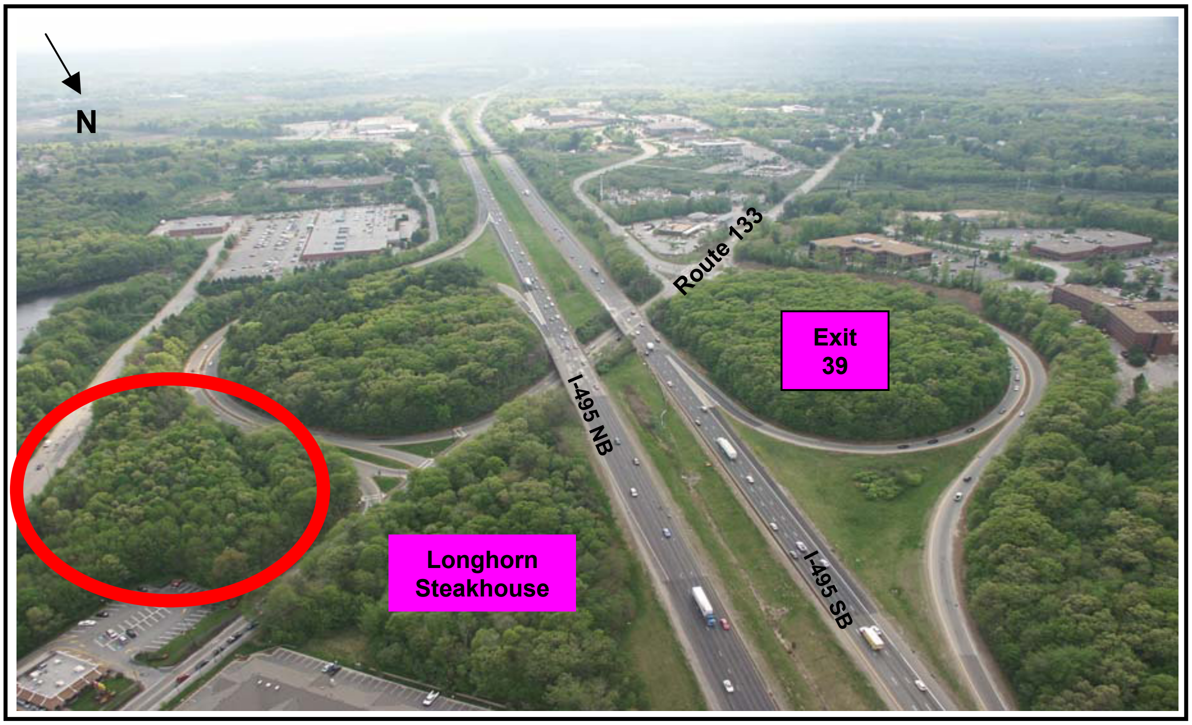
The next potential Park & Ride site identified is at Exit 50 in Haverhill, just to the south of the interchange on the west side of State Route 97, with access being via Carleton Street. Its location is shown on Figure 4-2b. The unusual characteristic of this particular potential Park & Ride site is that it consists of a parking lot for a church. A church parking lot would be particularly attractive for use as a Park & Ride lot since these types of lots are typically underutilized for church purposes during the weekday times when the availability of such lots is most critical for carpooling purposes. In return for use of the lot, the church would be eligible to receive monetary compensation. Of course, an agreement with this church would have to be worked out before usage of this existing parking lot as a Park & Ride lot on weekdays could be considered. This site is situated in the Eastern Segment of the I-495 study corridor, as is the following location.

The third potential site identified is also in Haverhill, specifically at Exit 52 where there is an interchange with State Route 110, as shown on Figure 4-3. Here, the potential Park & Ride site is currently a heavily wooded vacant land.

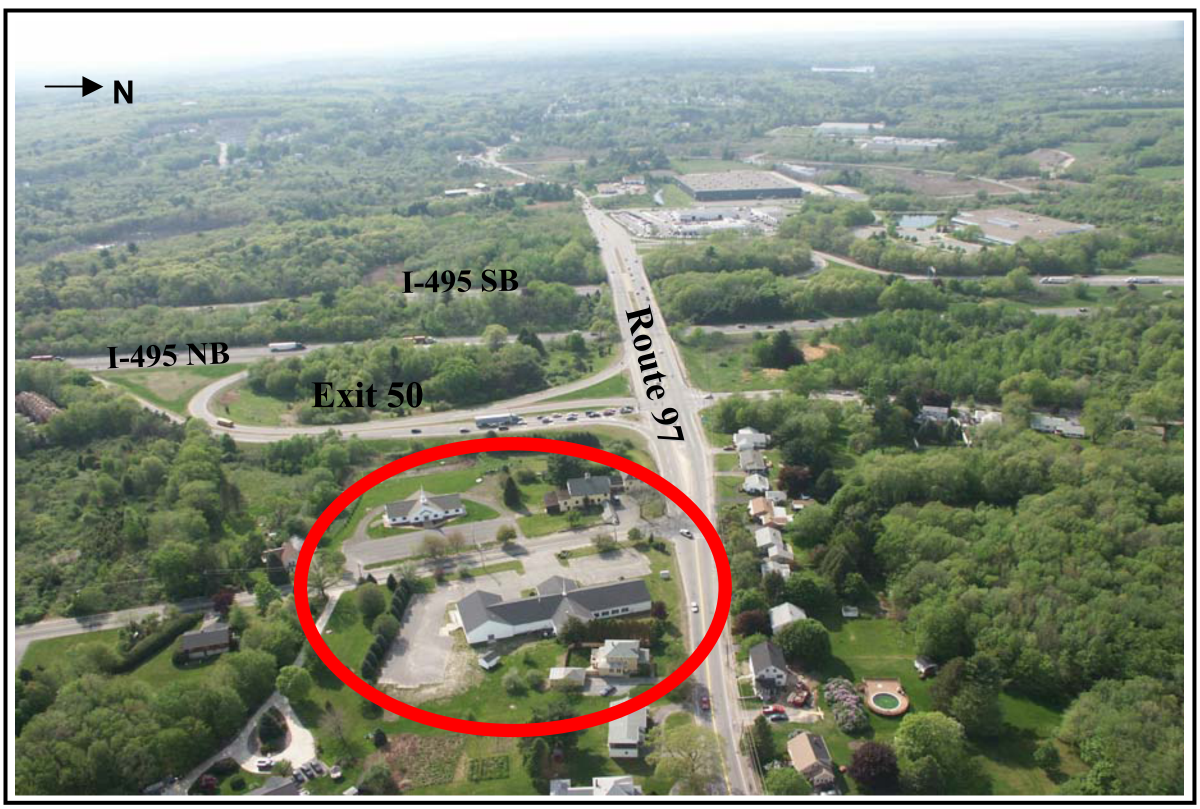
As with transit or land use modifications, the initial question regarding Park & Ride lots is: can increased reliance on carpooling address future year congestion on I-495?

To put Park & Ride lots potential contribution in perspective, if it is presumed that each potential lot could accommodate approximately 200 vehicles, on average, the total number of spaces that the three lots would provide would be 600. With follow-on assumptions for purposes of this example that they operate at 100 percent of capacity, that half of the vehicles arrive and depart during the peak hours, and that the benefits to I-495 in terms of reduced traffic is equally split by direction yields a maximum total reduction of traffic of only 150 vehicles per direction during the peak hours, or 50 vehicles per lane. In addition, all of this reduction would not take place throughout the length of the corridor. Rather it would be confined to various links, the exact locations of which have not been predicted. Averaged over the 40-mile length of the highway under study results in only slightly over 1 vehicle per lane mile. It is clear that this magnitude of traffic reduction represents only a very small fraction of the total number of vehicles using I-495 during the peak hours. Such a reduction is clearly not enough to address the level of

Potential Park and Ride Lot at Tewksbury, Exit 39 at Route 133



Potential Park and Ride Lot at Haverhill, Exit 50 at Route 97 in Church Parking Lot



Figures 4-2a – 4-2b
Potential Park and Ride Lot at Tewksbury, Exit 39 at Route 133
Potential Park and Ride Lot at Haverhill, Exit 50 at Route 97 in Church Parking Lot

Potential Park and Ride Lot in Haverhill at Exit 52 and Route 110

Figure 4-3
Potential Park and Ride Lot in Haverhill at Exit 52 and Route 110

service deficiencies identified in Chapter 2 and, especially, Chapter 3. However, they should not be viewed from that perspective alone.

As mentioned, Park & Ride lots also provide other benefits and should be considered as part of a total package containing multiple strategies to reduce the number of single-occupancy vehicles on area roadways and on I-495 in particular. Other benefits that can be derived from increased use of Park & Ride lots include, for example, improvements to air quality and reduced demand for gasoline. Accordingly, it is recommended that these potential locations for Park & Ride Lots be studied further by others for their feasibility of implementation.

4.2.4 Summary

The potential effects of promoting land uses with reduced trip generation rates, additional Park & Ride lots, and improvements to public transportation have been examined with regard to their ability to negate the need for or at least postpone the need for capacity increases on I-495 itself and at its intersections with the local street system. It has been determined that these types of strategies will not by themselves be able to negate this need.

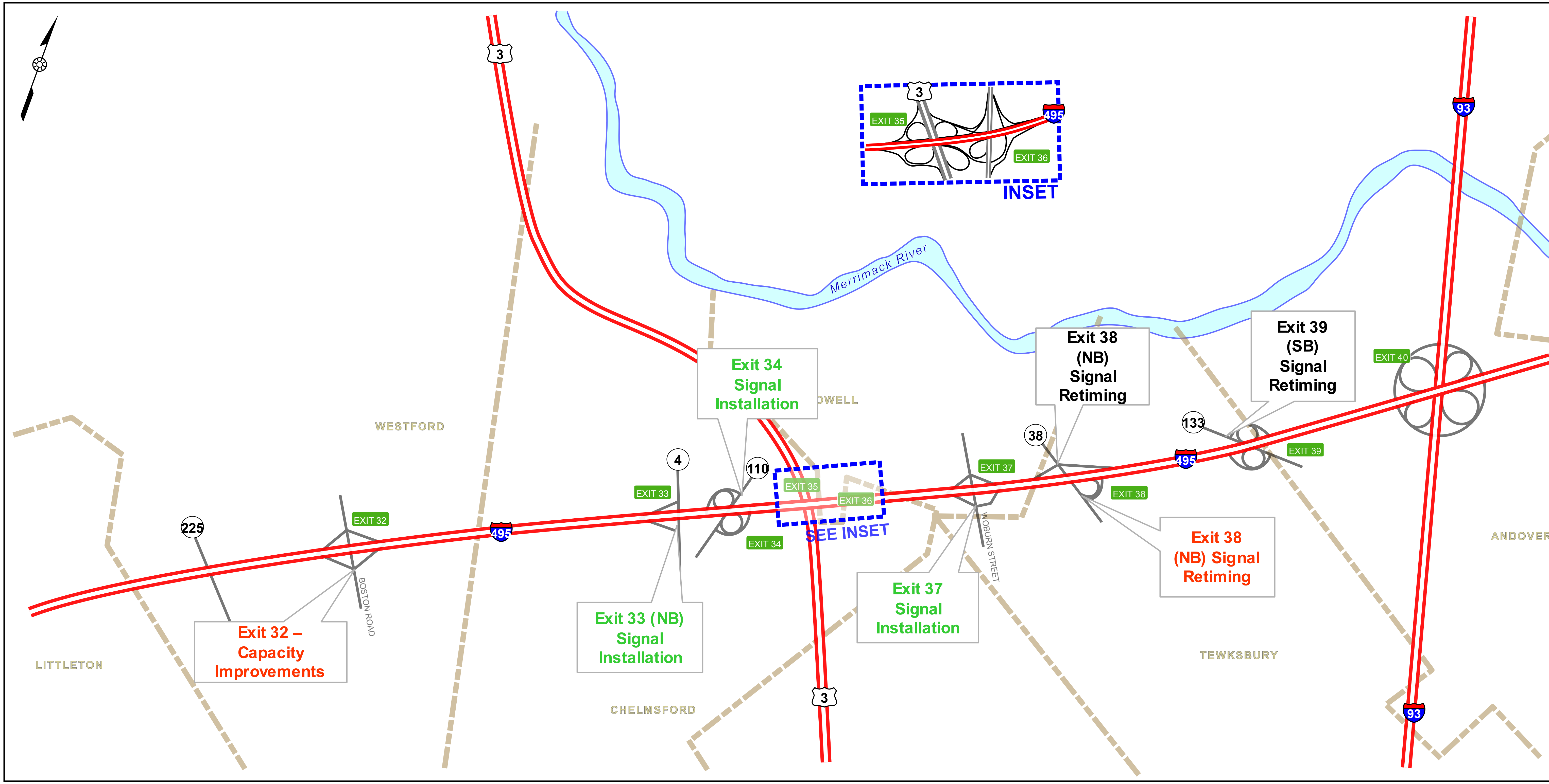
But, as noted earlier, these types of actions should not be dismissed for this reason. Rather, they should be viewed as key components of a total package of strategies to reduce vehicle demand, particularly of single-occupancy vehicles. And, they should be recognized for the many other benefits that they provide to individual users and to society as a whole.

4.3 Potential Near-Term Improvements (Less Than 2 Years)

In this section, potential near-term improvements to the study corridor's roadway network (I-495 along with its interchanges) are summarized for each Exit (interchange). The potential improvements are further categorized by their location in the Western Segment of the I-495 study corridor or in the Eastern Segment.

More detailed information regarding the analyses of levels of service before and after improvements can be found in Appendix D attached to this document.

Figures 4-4 and 4-5 show the locations of potential near-term intersection projects in the Western and Eastern Segments, respectively, of the study corridor. These near-term intersection projects would all involve retiming the existing traffic signal systems to respond more efficiently to current traffic volumes on the various approaches to the intersections involved.

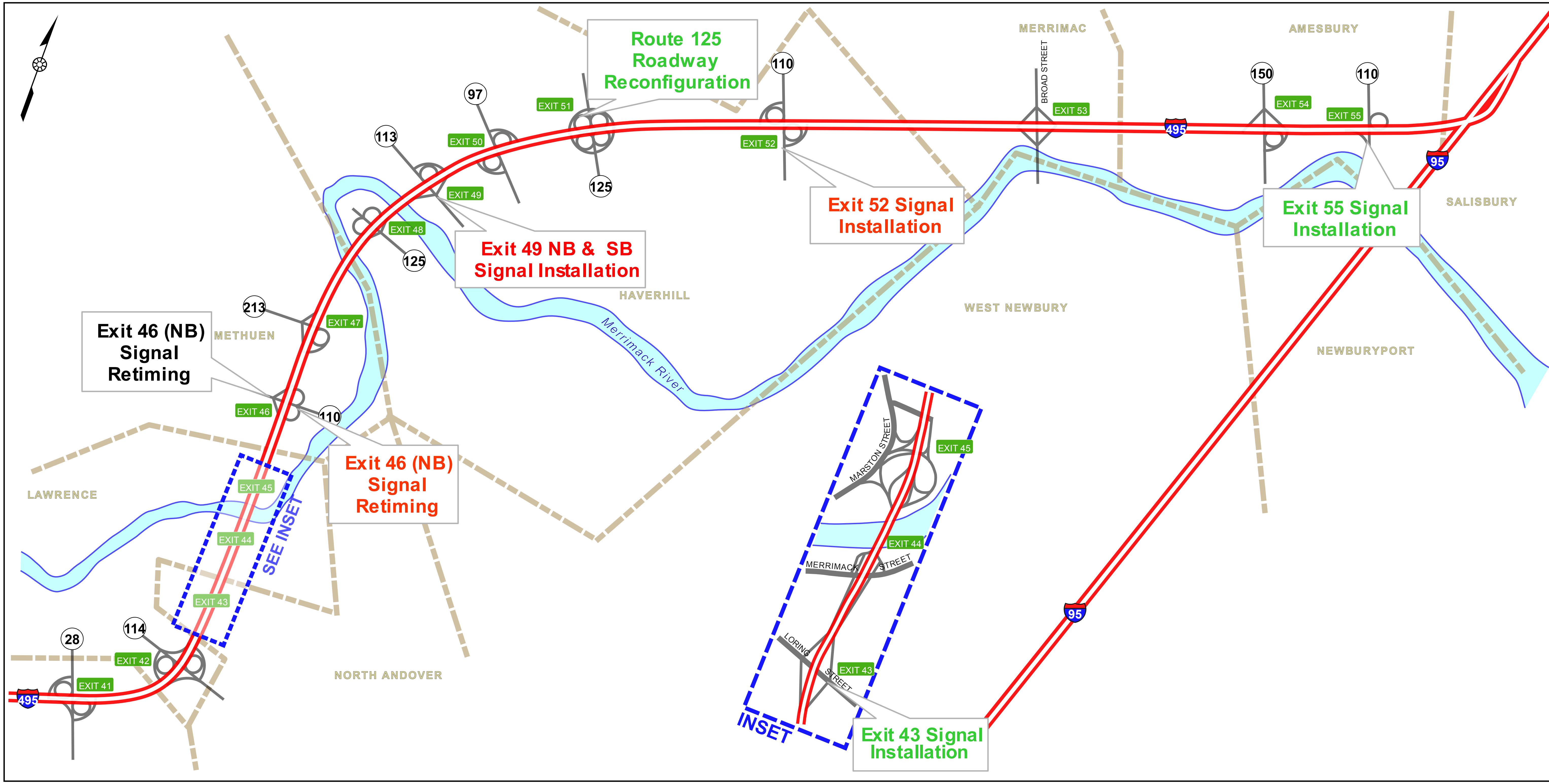


Legend

Near Term
Mid Term
Long Term

Figure 4-4*
Potential Intersection Improvements in Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



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Near Term
Mid Term
Long Term

Figure 4-5*
Potential Intersection Improvements in Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

By their nature, all potential near-term improvements are responses to identified existing problems. Since all the potential near-term improvements involve nothing other than changes to the timings of existing traffic signal systems, the implementation of these improvements would have no impacts on the environment. The characteristics of these improvements are such that they may be able to be implemented under MassHighway District maintenance contracts. MassHighway's District 4 in Arlington has responsibility for all of the communities in which the potential near-term improvement projects discussed in the following text are located.

4.3.1 Western Segment

Exit 38 (NB)/State Route 38 (Main Street) in Tewksbury

Near-term improvements at this interchange consist of the following:

- Retime Existing Traffic Signal System

The retiming of the existing traffic signal system would primarily improve operating conditions during the PM peak hour, where LOS for the intersection as a whole would improve from LOS D to LOS C. However, and more specifically, the LOS for the off-ramp approach to the intersection would improve from LOS E to LOS C, as would the left-turn and right-turn movements from the off-ramp. The intersection would continue to operate at LOS C during the AM peak hour with the signal retiming.

Exit 39 (SB)/State Route 133 (Andover Street) in Tewksbury

At this location, the following potential near-term improvement has been developed for consideration:

- Retime Existing Traffic Signal System

  This signal retiming effort would also result in improved overall intersection conditions during the PM peak hour, namely from LOS D to LOS B. With regard to more specific improvements that would result, the International Place approach as a whole and the through movement in particular would improve from LOS F to LOS D, while the exit ramp's left-turn movement would improve from LOS F to LOS C. As with Exit 38 NB, level of service for the intersection as a whole would remain at LOS C during the AM peak hour. However, the retiming of the signal system during the AM peak hour would involve a trade-off at this location. Specifically, without the retiming, the exit-ramp approach as a

whole currently operates at LOS E, as does the through movement from the ramp. This latter movement includes a queue on the ramp of close to 300 feet in length. With the retiming, LOS for both the ramp as a whole and the through movement would improve to LOS B in each case. But, simultaneously, LOS on the State Route 133 EB approach to the intersection as well as the through/right movement in particular would degrade from LOS B to LOS E as a result of the signal retiming.

4.3.2 Eastern Segment

Exit 46 (NB)/State Route 110 (Merrimack Street) in Methuen

One potential near-term improvement has been considered at this location:

- Retime Existing Traffic Signal System
  Retiming the existing traffic signal system here would have minimal effects during the AM peak period but would be of much more benefit during the PM peak period. Specifically, during the PM peak period, the key beneficiary of the retiming effort would be the left/through movement at the end of the off-ramp. There, LOS would improve from LOS E to LOS C. Average delay for this combined movement would decrease from 58 seconds to 30 seconds, while queue length would decrease from 347 feet to 186 feet.

4.4 Potential Mid-Term Improvements (2 to 8 Years)

Mid-term projects studied for implementation at locations along the I-495 corridor are presented in this section. Projects include those considered for the intersections of I-495's ramps with the local street systems. Consequently, ramp improvements involve installation of traffic signals, often in conjunction with the creation of turning lanes by means of pavement re-striping. Once in place, these intersection improvements will create acceptable peak hour LOS at all study area intersections. All mid-term intersection improvements address operational problems that exist in 2006.

Another category of mid-term improvement involves extension of the acceleration and deceleration lanes identified in Table B-8 in Appendix B. As discussed in Chapter 2, these locations experience LOS F conditions due to the volume of peak hour traffic volume on I-495's existing lanes. The only way to improve LOS at these locations is to add a lane to I-495 to allow traffic volumes to disperse and, thus, create gaps in traffic for vehicles to enter or exit the I-495 traffic stream without having to wait for a gap in traffic.

By achieving the design standard in terms of length for these deficient locations, it is anticipated that driver comfort will increase as anxiety will decrease somewhat as additional distance and, thus, time will be created to enter/exit the main line traffic flow. This additional distance has the potential to reduce crashes. Because the cost to achieve these lane improvements is small, their potential, albeit limited, benefits are considered worth pursuing.

Please refer to Figures 4-4 and 4-5 for graphical illustrations of the locations of potential mid-term improvements for intersections in the Western and Eastern Segments of the study corridor, respectively. In this case, the potential intersection improvements would typically involve the installation of traffic signal systems at locations that today are unsignalized.

Figures 4-6 shows the locations of potential mid-term acceleration and deceleration lane improvement projects in the Western Segment of the study corridor, while the same information for the Eastern Segment is illustrated on Figure 4-7. In all cases, these potential improvements would involve lengthening the existing acceleration and deceleration lanes at Exits on I-495 to bring them into conformance with current standards regarding the required lengths for such roadway features. Such lengthening is designed to improve safety and congestion at each location.

As with the potential near-term improvements discussed previously, potential mid-term improvements are also responses to existing problems that have been identified as part of this study. Some of the potential mid-term improvements, such as pavement re-striping to lengthen existing acceleration and deceleration lanes on I-495 and pavement re-striping on local streets at interchanges to create separate left-turn lanes, may be able to be implemented under MassHighway District maintenance contracts. Other mid-term improvements, including the installation of new traffic signal systems, the reconfiguration of a portion of State Route 125, and the study of new connections between I-495 and I-95, would require the issuance of separate design, construction, and planning contracts, as appropriate. In all cases, potential mid-term improvements could be expected to be undertaken entirely within the existing roadway rights-of-way and are of the type that environmental impacts would be minimal or non-existent. However, based on MassGIS data, it would appear that the potential traffic signal installation work at Exit 33 NB in Chelmsford and Exit 55 NB in Amesbury, as well as the potential roadway reconfiguration work on State Route 125 north of Exit 51 in Haverhill, might be located in the buffer zones of a protected resource. If later confirmed, coordination with the Conservation Commissions in those three communities will be necessary.

More detailed information about the specific mid-term projects for intersections and acceleration and deceleration lanes is presented in the following text.

4.4.1 Western Segment

Exit 32 (NB)/Boston Road in Westford

- Lengthen Acceleration Lane

  At this location, the improvement is to lengthen the existing acceleration lane by 70 feet from its current 750-foot length to 820 feet to bring it up to current standards. The work would be accomplished by re-striping the existing pavement.

Exit 33 (NB)/State Route 4 (North Road) in Chelmsford

- Install Traffic Signal System

  The installation of a traffic signal system at this location would improve the left-turn movement from the off-ramp from LOS F to LOS B during both the AM and PM peak hours, while also substantially reducing average delays for this movement.

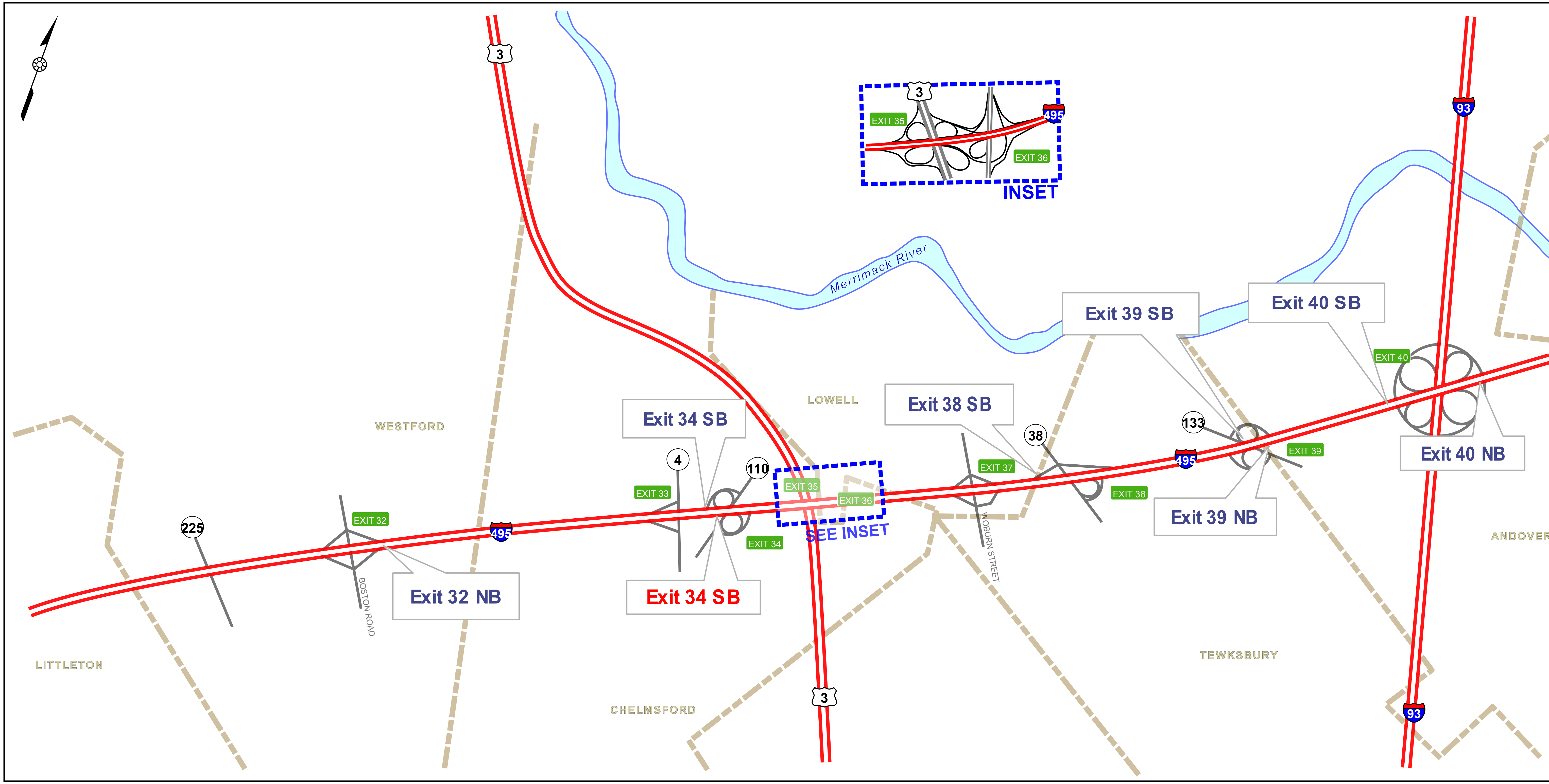
  Existing conditions for this intersection are shown on Figure 4-8. This potential improvement, the results anticipated to be obtained, and its estimated cost are also summarized on Figure 4-8.

Exit 34 (NB)/State Route 110 (Chelmsford Street) in Chelmsford

- Install Traffic Signal System and Add Left-Turn Lane on State Route 110

  With the potential installation of a new traffic signal system at this intersection, the left-turn movement at the end of the off-ramp would remain at LOS C during the AM peak hour but would improve from LOS F to LOS D during the PM peak hour.

  Creation of a new left-turn lane on State Route 110 to serve the on-ramp to I-495 NB would be accomplished by re-striping the existing pavement. No additional pavement width on State Route 110 would be required in order to create this turning lane.



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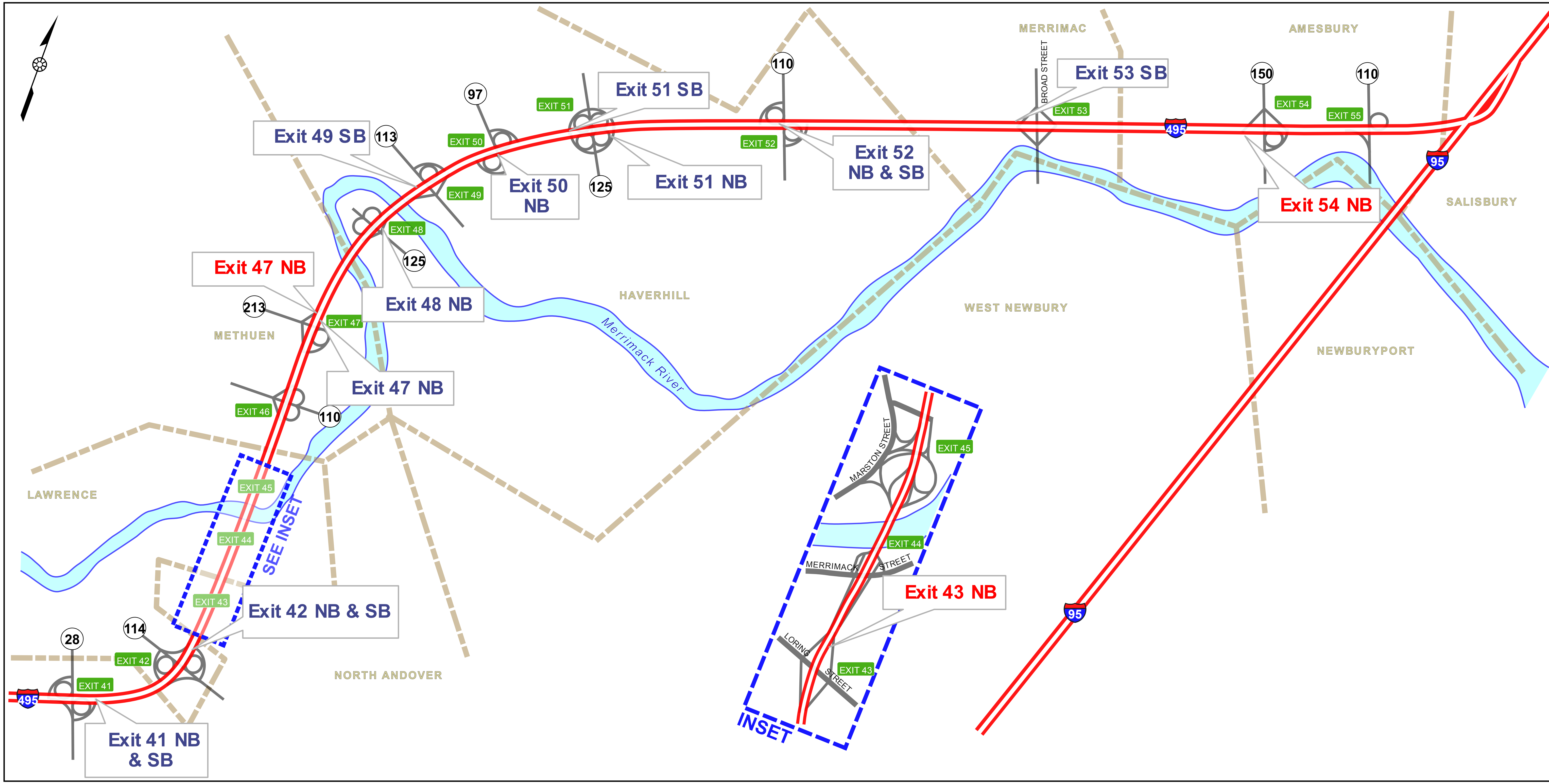
Acceleration Lane Location for Improvement

Deceleration Lane Location for Improvement

Figure 4-6*
Acceleration and Deceleration Lane Improvements in Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



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Acceleration Lane Location for Improvement

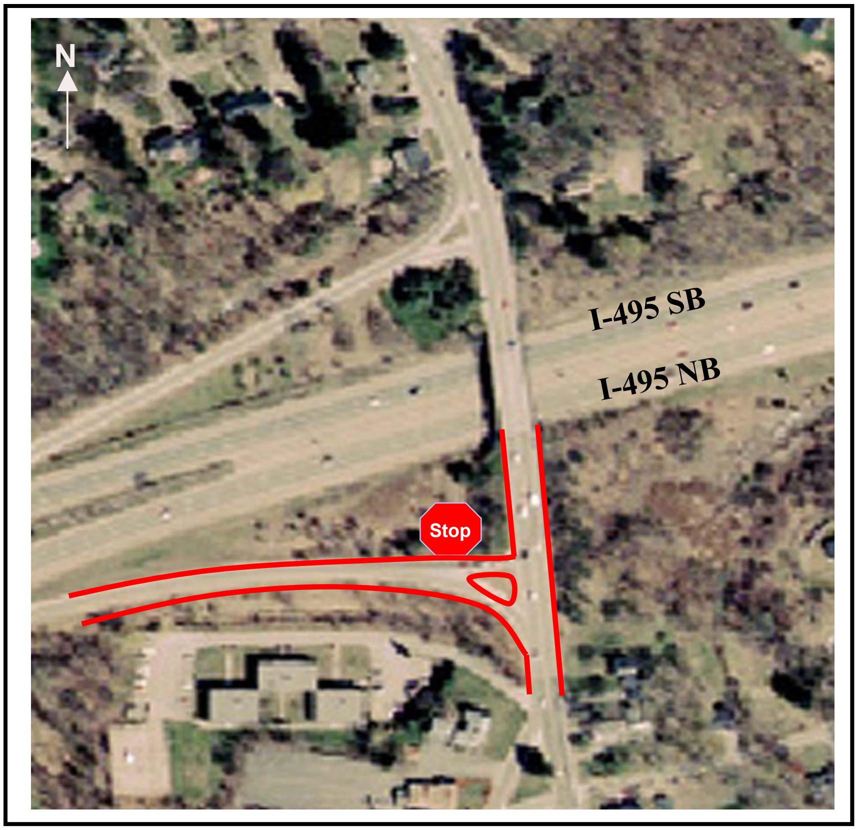
Deceleration Lane Location for Improvement

Figure 4-7*

Acceleration and Deceleration Lane Improvements in Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

Exit 33 NB at Route 4 in Chelmsford (Existing)



Exit 33 NB at Route 4 in Chelmsford (Proposed)

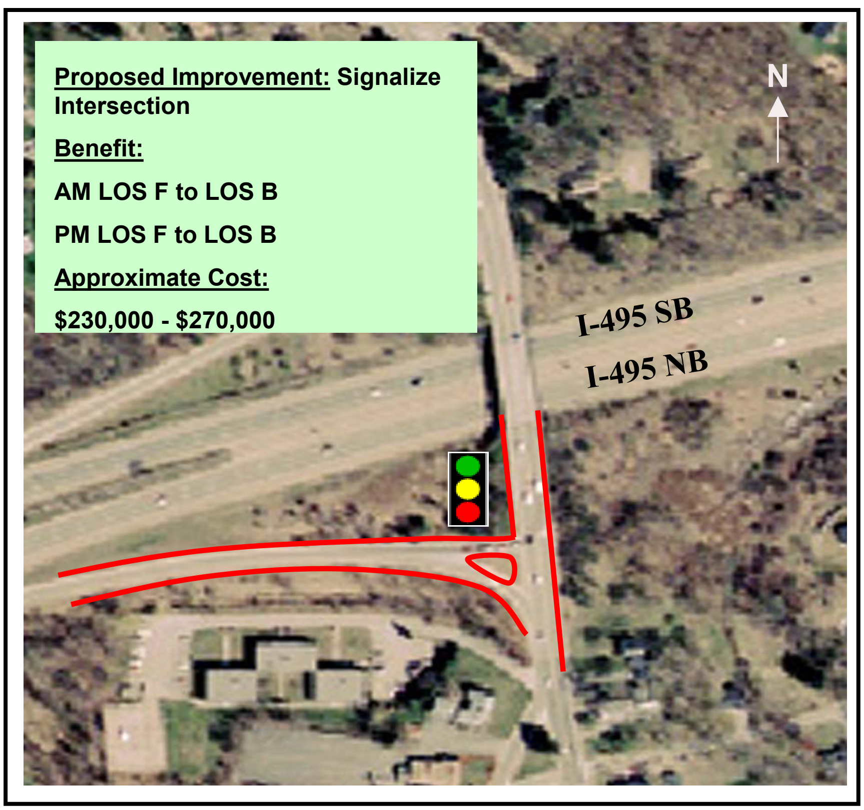


Figure 4-8
Existing Condition and Proposed Improvement at Exit 33 NB and Route 4 in Chelmsford

Figure 4-9 illustrates existing conditions at this intersection and summarizes the potential improvements.

Exit 34 (SB)/State Route 110 (Chelmsford Street) in Chelmsford

- Install Traffic Signal System and Add Left-Turn Lane on State Route 110

  As a result of the installation of a traffic signal system at this location, during the AM peak hour conditions for the left-turn movement at the end of the off-ramp would remain at LOS C but would improve from LOS F to LOS D during the PM peak hour. During this latter period, average delay would decrease substantially, from 526 seconds to 27 seconds.

  Creation of a new left-turn lane on State Route 110 by re-striping the existing pavement would better accommodate the movement from State Route 110 to I-495 SB.

  Existing conditions at this intersection and these two potential improvements for this intersection are summarized on Figure 4-10.

- Lengthen Acceleration Lane

  The existing acceleration lane would be lengthened by 320 feet from its current length of 500 feet to a new total of 820 feet, the length required for this location. The potential lengthening would be accomplished by re-striping the existing pavement.

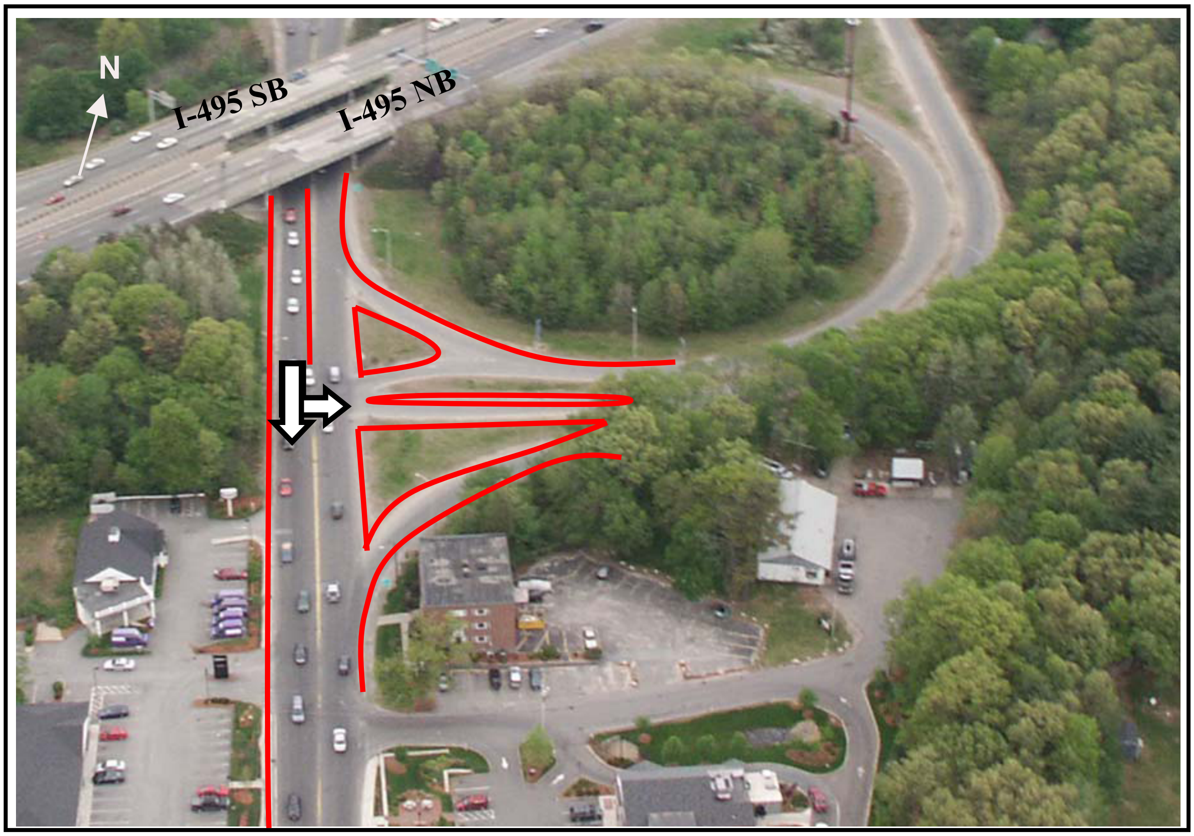
- Lengthen Deceleration Lane

  The deceleration lane at this location would be lengthened by 220 feet from its existing length of 300 feet to a new total of 520 feet, the required length for this location. Again, this lengthening would be achieved by re-striping the existing pavement.

Exit 37 (NB)/Woburn Street in Lowell

- Install Traffic Signal System and Add Left-Turn Lane on Woburn Street

Exit 34 NB at Route 110 in Chelmsford (Existing)



Exit 34 NB at Route 110 in Chelmsford (Proposed)

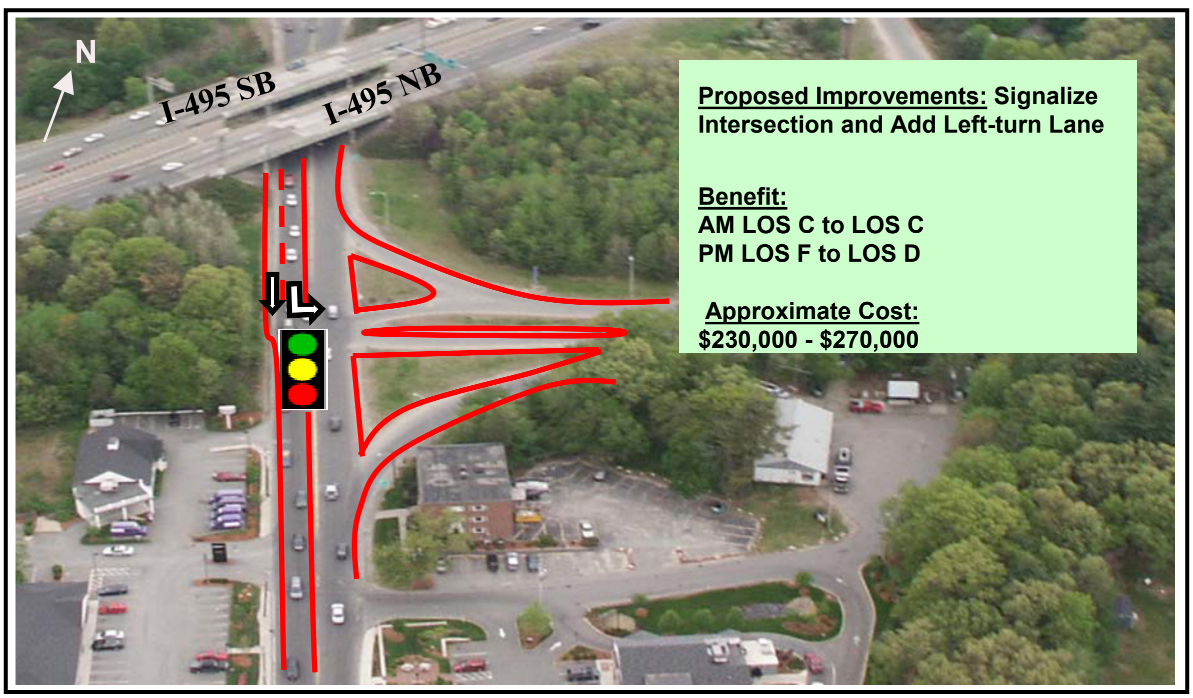
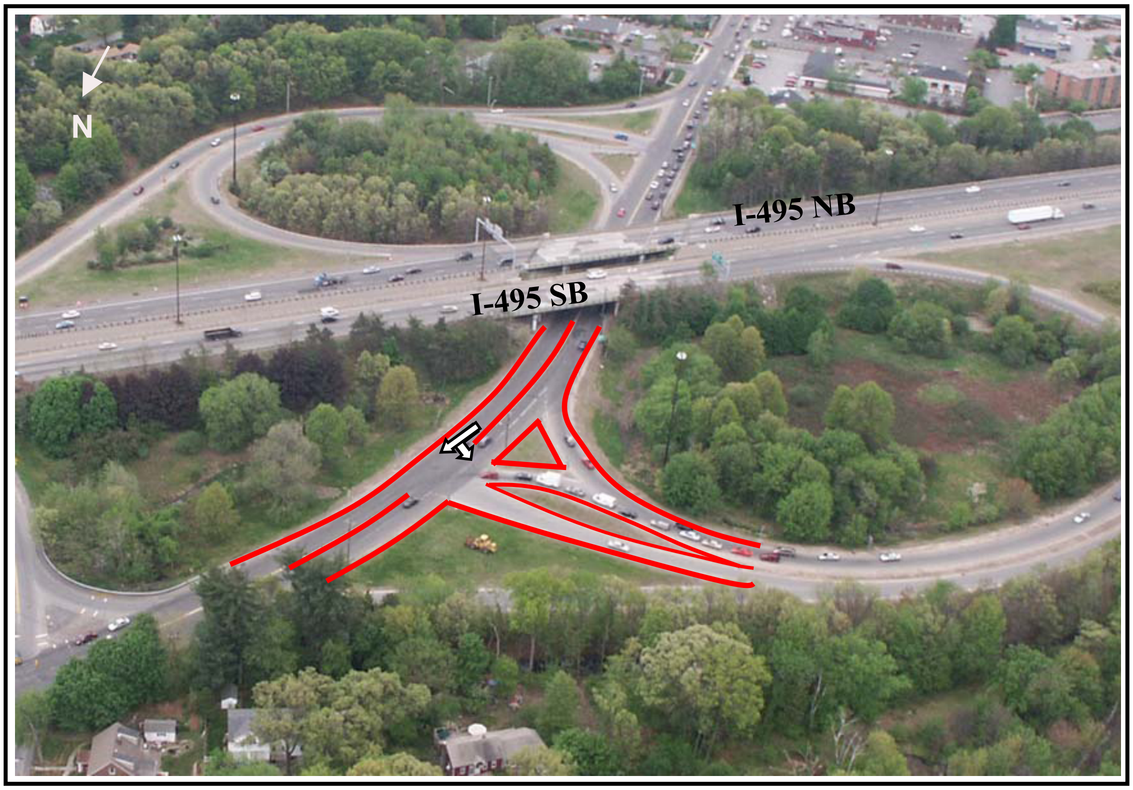


Figure 4-9
Existing Condition and Proposed Improvement at Exit 34 NB and Route 110 in Chelmsford

Exit 34 SB at Route 110 in Chelmsford (Existing)



Exit 34 SB at Route 110 in Chelmsford (Proposed)

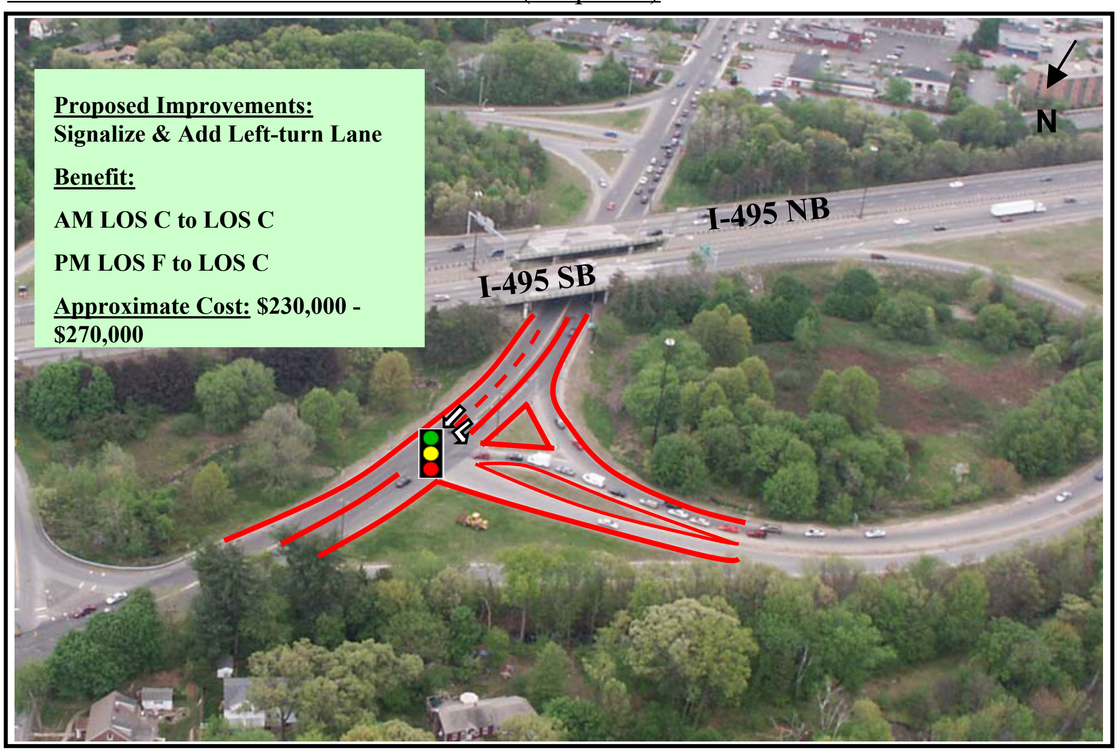


Figure 4-10
Existing Condition and Proposed Improvement at Exit 34 SB and Route 110 in Chelmsford

The installation of a traffic signal system here would result in the left/through movement at the end of the off-ramp improving during the AM peak hour from LOS F to LOS B, with average delays decreasing from 68 seconds to 17 seconds. During that same period, the right-turn movement at the end of the ramp would improve from LOS D to LOS C, with average delay decreasing from 28 seconds to 22 seconds. During the PM peak hour, the proposed signalization would improve the left-turn movement from LOS F to LOS D. Average delay for this combined movement would decrease from 234 seconds to only 42 seconds.

Figure 4-11 shows the existing conditions and the potential improvements at this location.

<u>Exit 37 (SB)/Woburn Street in Lowell</u>

- Install Traffic Signal System and Add Left-Turn Lane on Woburn Street

During the AM peak hour, the signalization of this intersection would result in the level of service for the left-turn movement at the end of the off-ramp improving from LOS F to LOC C, along with the associated decrease in average delay for this movement decreasing from 622 seconds to 22 seconds. Similar results would be found during the PM peak hour for this same movement. Specifically, level of service would improve from LOS F to LOS D, while average delay for this movement would decrease from 576 seconds to only 37 seconds.

Figure 4-12 illustrates the existing configuration of this intersection and a depiction of potential improvements under consideration.

<u>Exit 38 (SB)/State Route 38 in Tewksbury</u>

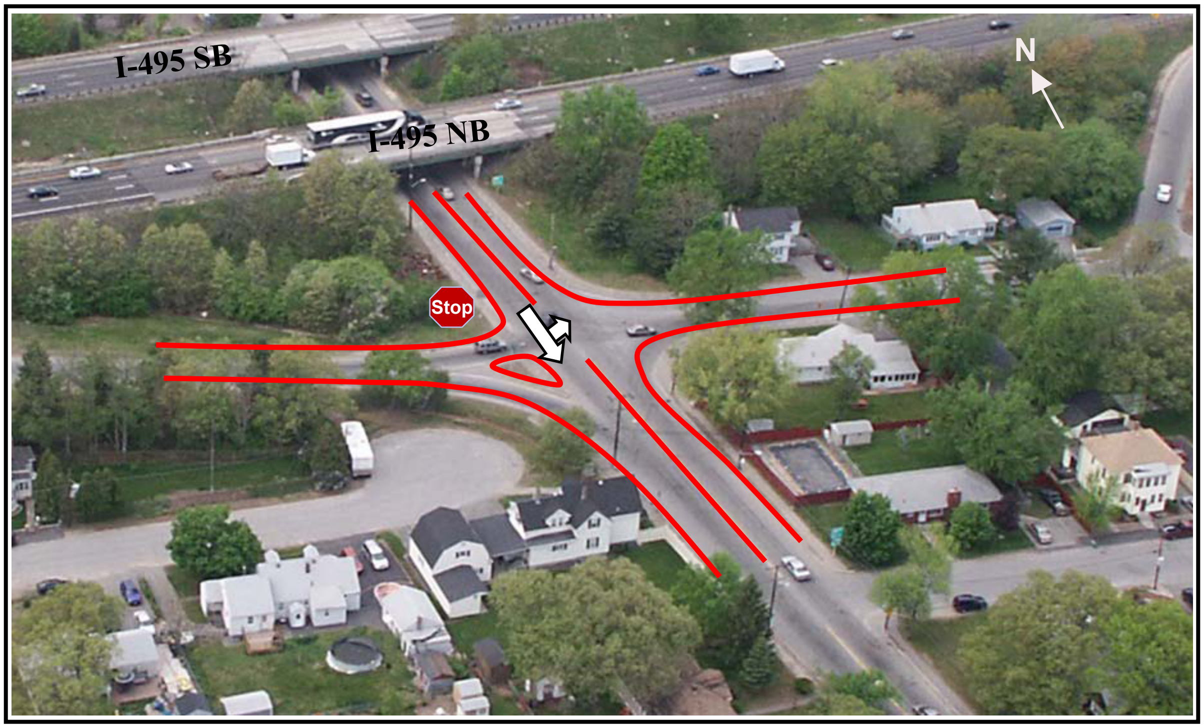
- Lengthen Acceleration Lane

At this location, the existing 900-foot acceleration lane would be lengthened by 450 feet, resulting in a new length of 1,350 feet, which is the required length. Lengthening would be achieved by re-striping the existing pavement.

<u>Exit 39 (NB)/State Route 133 (Andover Street) in Tewksbury</u>

- Lengthen Acceleration Lane

Exit 37 NB at Woburn Street in Lowell (Existing)



Exit 37 NB at Woburn Street in Lowell (Proposed)

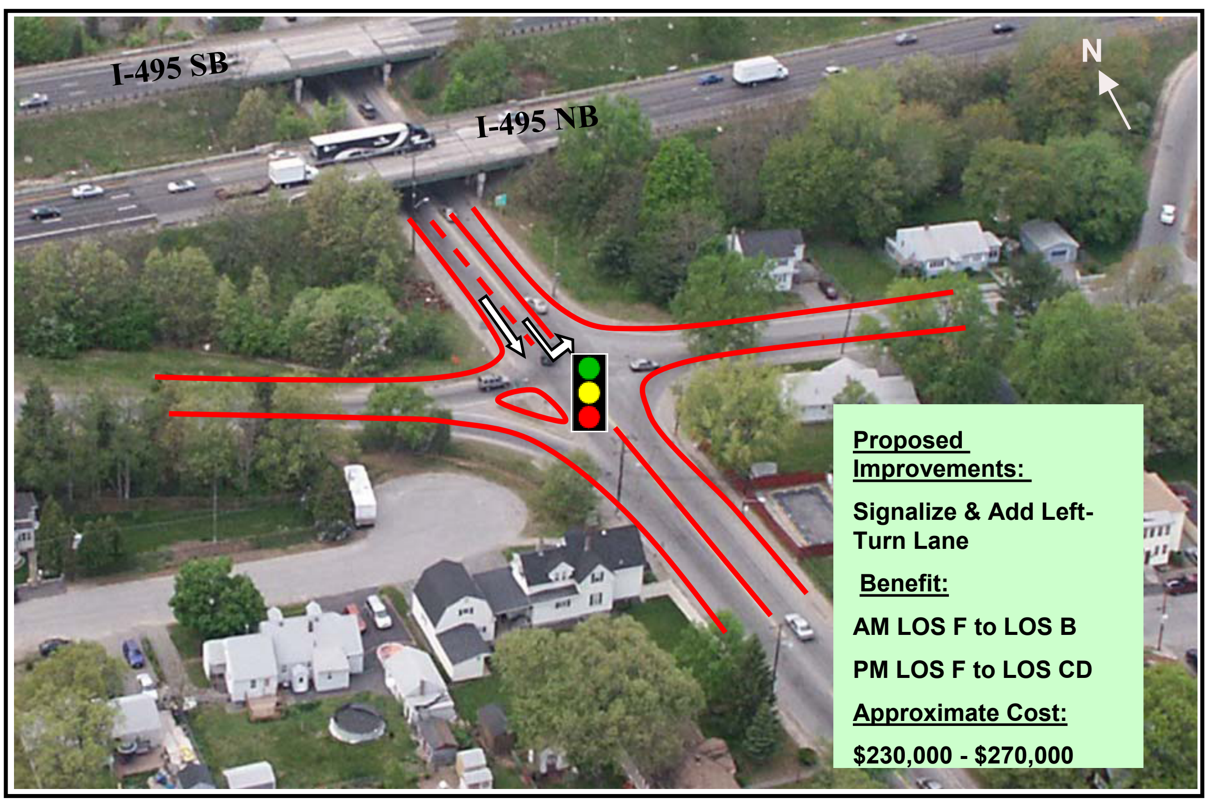
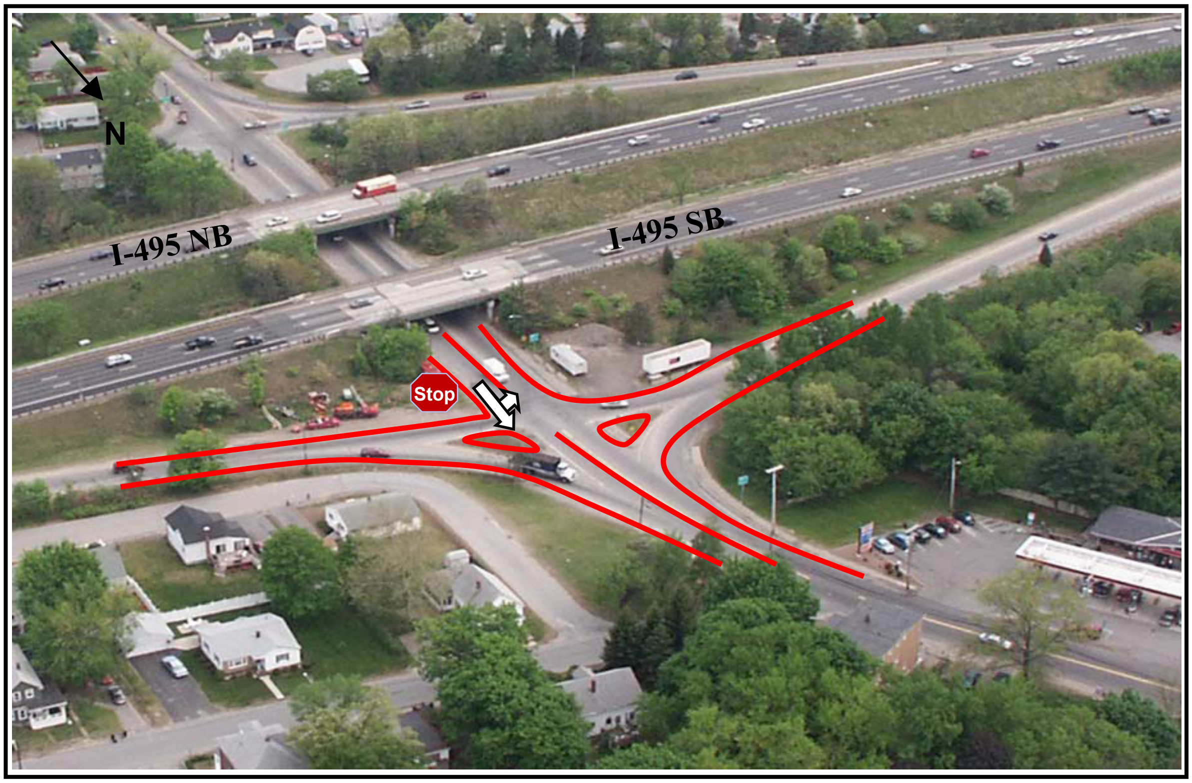


Figure 4-11

Existing Condition and Proposed Improvement at Exit 37 NB and Woburn Street in Lowell

Exit 37 SB at Woburn Street in Lowell (Existing)



Exit 37 SB at Woburn Street in Lowell (Proposed)

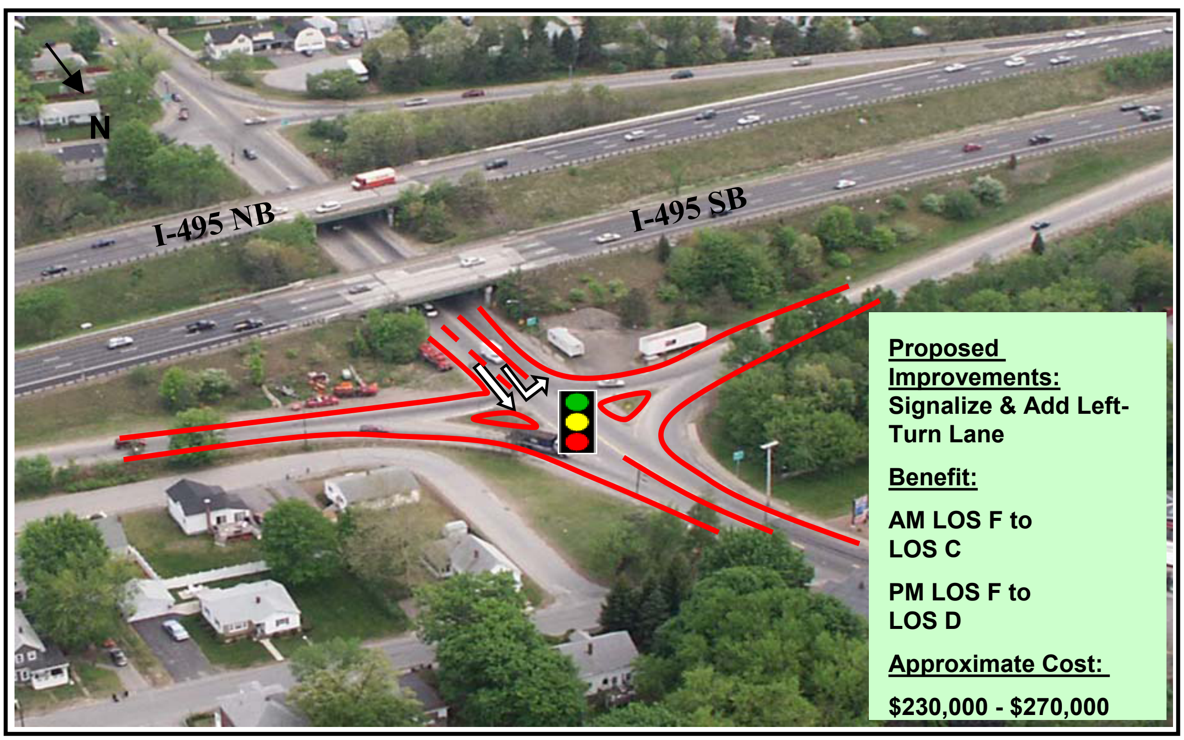


Figure 4-12
Existing Condition and Proposed Improvement at Exit 37 SB and Woburn Street in Lowell

Adding 550 feet to the existing acceleration lane length of 870 feet would bring the lane up to the required 1,420-foot length. Lengthening would be accomplished by re-striping the existing pavement.

Exit 39 (SB)/State Route 133 (Andover Street) in Tewksbury

- Lengthen Acceleration Lane

For this location, the project would be to lengthen the existing 690-foot acceleration lane by 730 feet so as to bring the lane to the required 1,420-foot length, with this being achieved by re-striping the existing pavement.

Exit 40 (NB)/I-93 in Andover

- Lengthen Acceleration Lane

The project here would call for the existing 720-foot acceleration lane to be increased to the required 1,420-foot length by re-striping the existing pavement to achieve the required 700-foot increase in length.

Exit 40 (SB)/I-93 in Andover

- Lengthen Acceleration Lane

The existing 1,040-foot length of the acceleration lane would be lengthened by 380 feet, resulting in a new length of 1,420 feet that would meet the required length for this location. Re-striping of the existing pavement would be employed to achieve this new length.

4.4.2 Eastern Segment

Exit 41 (NB)/State Route 28 (North Main Street) in Andover

- Lengthen Acceleration Lane

This improvement would involve lengthening the existing 580-foot acceleration lane by 840 feet to achieve the required length of 1,420 feet. Re-striping the existing pavement would be employed.

Exit 41 (SB)/State Route 28 (North Main Street) in Andover

- Lengthen Acceleration Lane

  In order to achieve the required 1,420-foot length of the acceleration lane here, the existing 1,340-foot lane would be lengthened by 80 feet by means of pavement re-striping.

Exit 42 (NB)/State Route 114 (Winthrop Avenue) in Lawrence

- Lengthen Acceleration Lane

  Here, lengthening of the existing 880-foot acceleration lane by 540 feet would bring the lane up to the 1,420-foot standard for this location. Pavement re-striping would be employed to achieve this new length.

Exit 42 (SB)/State Route 114 (Winthrop Avenue) in Lawrence

- Lengthen Acceleration Lane

  The 1,420-foot required length of the acceleration lane here would be achieved by lengthening, by means of pavement re-striping, the existing 870-foot lane by 550 feet.

Exit 43 (NB)/Massachusetts Avenue in North Andover

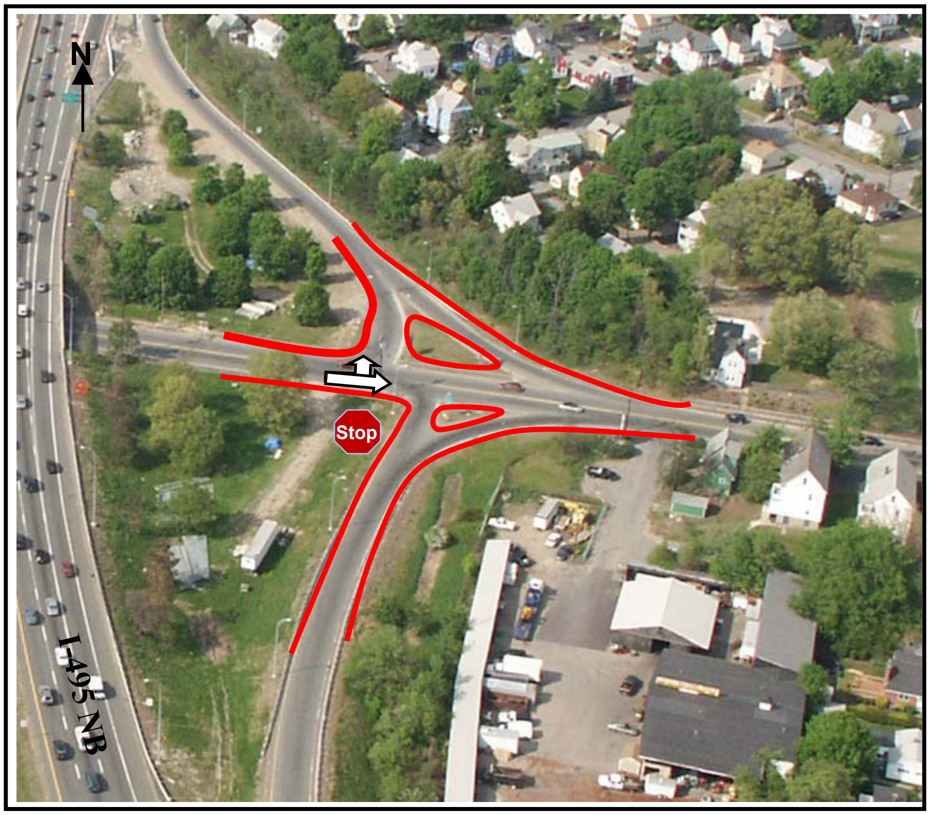
- Install Traffic Signal System and Add Left-Turn Lane on Massachusetts Avenue

  A traffic signal system would be installed at this location. The key improvement resulting from this installation would be for the left-turn movement at the end of the off-ramp. During the AM peak hour, level of service for this movement would improve from LOS F to LOS C, accompanied by a decrease in average delay for this movement from 159 seconds to 32 seconds. During the PM peak hour, level of service for this same movement would also improve from LOS F to LOS C. In this case, average delay would be reduced from 83 seconds to 21 seconds.

  Re-striping the existing pavement would create a left-turn lane from Massachusetts Avenue to I-495 NB.

  The existing configuration, improvements, and results are illustrated on Figure 4-13.

Exit 43 NB at Mass Ave in Lawrence (Existing)



Exit 43 NB at Mass Ave in Lawrence (Proposed)

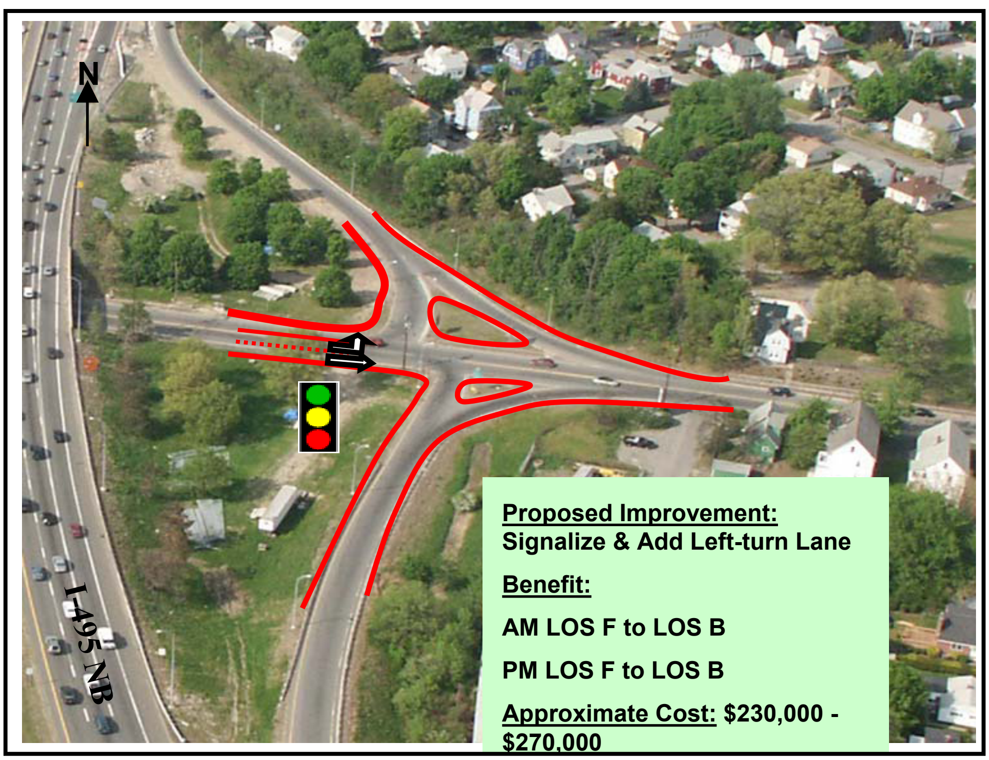


Figure 4-13
Existing Condition and Proposed Improvement at Exit 43 NB and Mass Ave in Lawrence

- Lengthen Deceleration Lane

  The existing 220-foot deceleration lane would be brought to its required length of 280 feet by re-striping the existing pavement to add another 60 feet in length.

Exit 43 (SB)/Loring Street in Lawrence

- Install Traffic Signal System and Add Left-Turn Lane on Loring Street (Massachusetts Avenue)

  The installation of a traffic signal at this location would have only minor effects on the level of service of the left-turn movement at the end of the ramp during the AM peak hour, as LOS would change from LOS D to LOS C. More important would be the signal installation's effect during the PM peak hour when level of service would improve from LOS F to LOS B. This PM peak hour improvement would be accompanied by a decrease in average travel delay for this movement from 83 seconds to 20 seconds.

  An additional improvement would be the creation of a left-turn lane from Loring Street/Massachusetts Avenue to I-495 SB, to be accomplished by re-striping the existing pavement.

  Figure 4-14 shows existing conditions at this location and illustrates the potential improvements and resulting benefits.

Exit 47 (NB)/State Route 213 (Albert Slack Highway) in Methuen

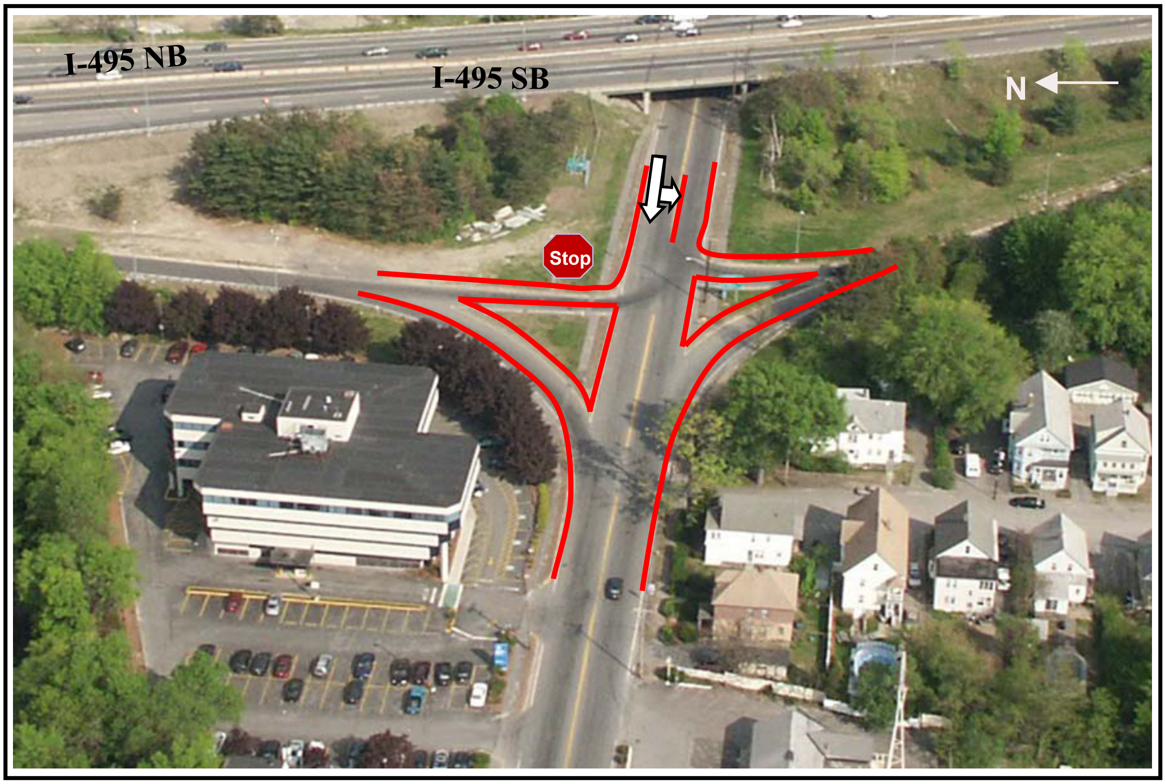
- Lengthen Acceleration Lane

  Lengthening the existing 730-foot acceleration lane at this location by 690 feet would achieve the required 1,420-foot length. This lengthening would be accomplished through pavement re-striping.

- Lengthen Deceleration Lane

  Also under consideration here would be the lengthening of the existing deceleration lane. Specifically, adding 40 feet to the existing 300-foot deceleration lane would result in a facility meeting the 340-foot requirement.

Exit 43 SB at Loring Street in Lawrence (Existing)



Exit 43 SB at Loring Street in Lawrence (Proposed)

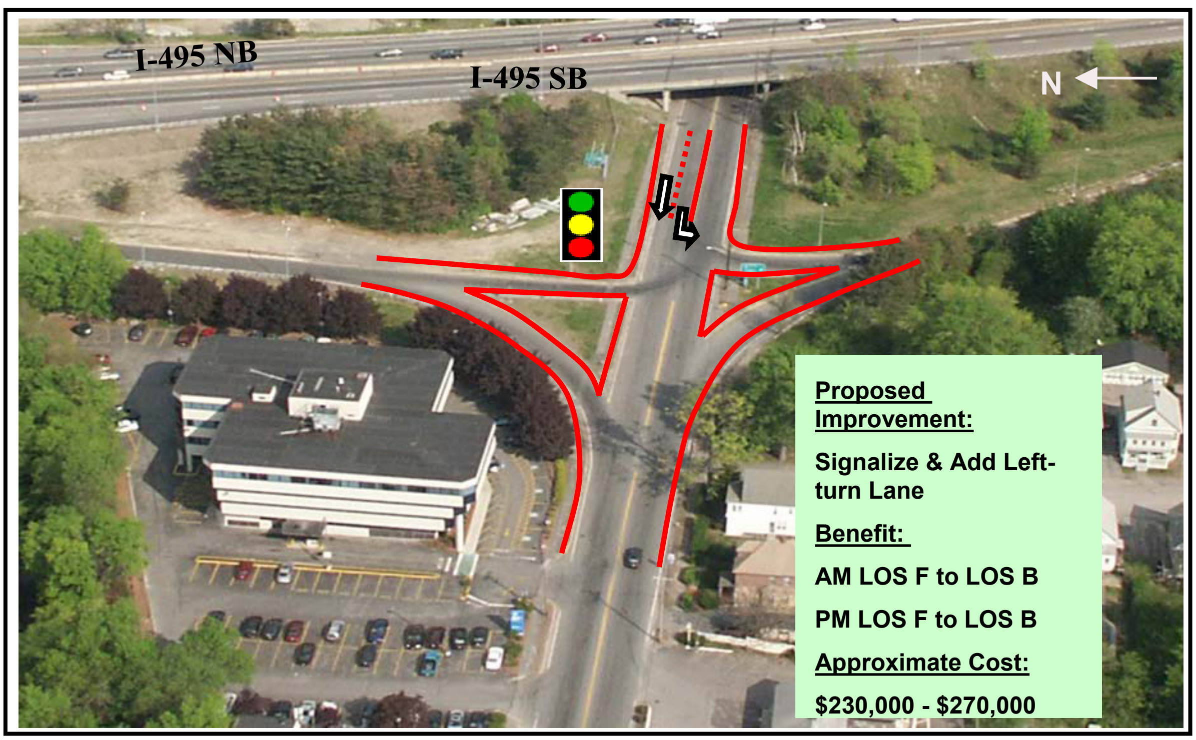


Figure 4-14
Existing Condition and Proposed Improvement at Exit 43 SB and Loring Street in Lawrence

Exit 48 (NB)/State Route 125 in Haverhill

- Lengthen Acceleration Lane

  Here would be added 470 feet to the existing 530-foot acceleration lane to result in the required 1000-foot length. This lengthening would be achieved by means of pavement re-striping.

Exit 49 (SB)/State Routes 110/113 (River Street) in Haverhill

- Lengthen Acceleration Lane

  The acceleration lane at this exit would be lengthened by 720 feet, from its current length of 700 feet, to result in a total length of the required 1,420 feet. The lengthening would be achieved with pavement re-striping.

Exit 50 (NB)/State Route 97 (Broadway) in Haverhill

- Lengthen Acceleration Lane

  At this location, the existing 1,040-foot acceleration lane would be lengthened by 380 feet. This action would result in a new total length of 1,420 feet, which meets this site’s requirement. This lengthening would involve pavement re-striping.

Exit 51 (NB)/State Route 125 (Main Street) in Haverhill

- Lengthen Acceleration Lane

  The required 1,420-foot acceleration length at this location would be achieved by doubling the existing length of 720 feet through pavement re-striping.

- Reconfigure State Route 125 Roadway

  A potential improvement here would be the reconfiguration of the cross-section of State Route 125 from the interchange north to Jaffarian Road, a distance of approximately 1.1 miles (see Figure 4-15a). During the PM peak hour, traffic backs up on this section of roadway as vehicles traveling in the northbound direction toward New Hampshire are forced to merge from the two northbound travel lanes available at the interchange to only one travel lane north of the interchange, as shown in Figure 4-15b. This section of roadway is presently configured with one 12-foot travel lane and 3-foot shoulder in each direction, along with a

14-foot center two-way left-turn lane (Figures 4-16a and 4-16b). The revised configuration would include one 12-foot southbound travel lane with 5-foot shoulder and two 12-foot northbound travel lanes with 5-foot shoulder (Figure 4-16c). It would allow northbound traffic a much longer distance in which to merge into one lane, thus taking any congestion caused by the merge away from the interchange.

Exit 51 (SB)/State Route 125 (Main Street) in Haverhill

- Lengthen Acceleration Lane

  The potential improvement at this location would call for the existing 800-foot acceleration lane to be increased in length by 550 feet to a new length of 1,350 feet, the required length. This lengthening would involve pavement re-striping only.

- Reconfigure State Route 125 Roadway

  See comments under Exit 51 (NB) above and once again refer to Figures 4-15a, 4-15b, 4-16a, 4-16b, and 4-16c.

Exit 52 (NB)/State Route 110 (Amesbury Road) in Haverhill

- Lengthen Acceleration Lane

  Lengthening the existing 1,070-foot lane by 160 feet using pavement re-striping would attain the required 1,230-foot acceleration lane here.

Exit 52 (SB)/State Route 110 (Amesbury Road) in Haverhill

- Lengthen Acceleration Lane

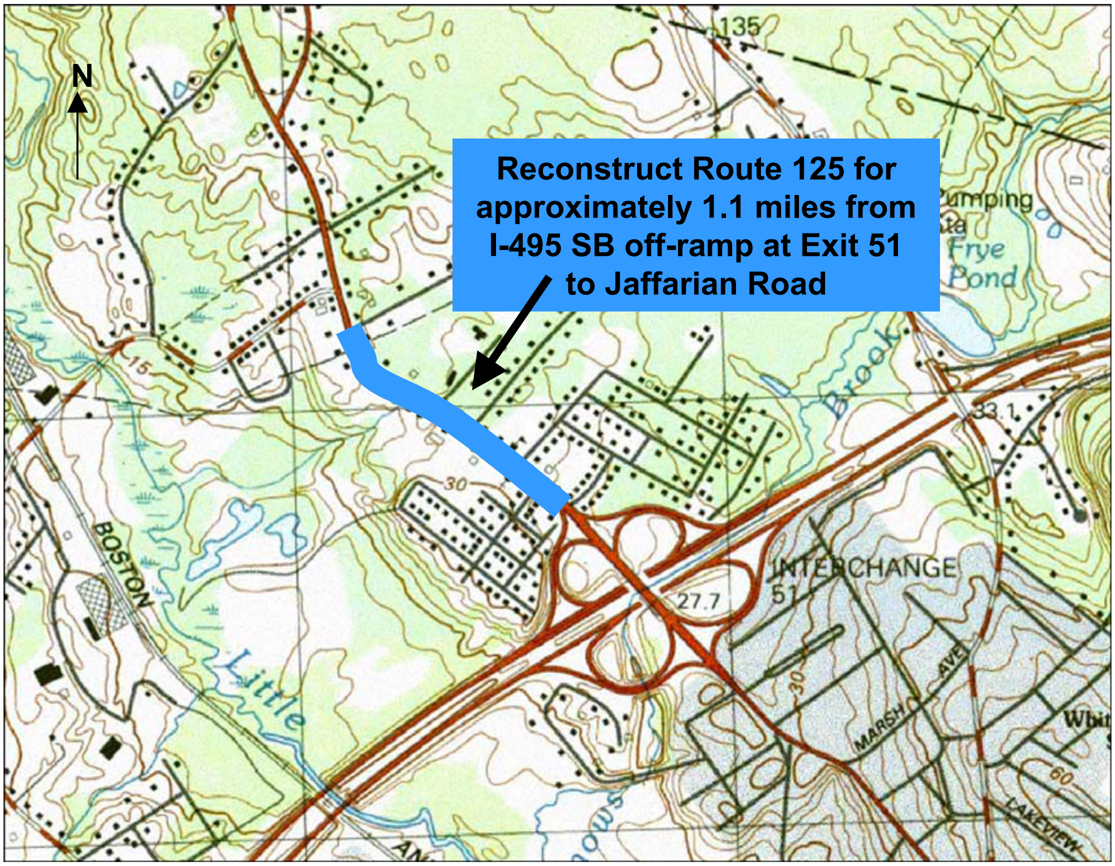
  The length of the existing 740-foot acceleration lane would be increased by 490 feet, resulting in the required length of 1,230 feet. This lengthening would be accomplished by means of pavement re-striping.

Exit 53 (SB)/Broad Street in Merrimack

- Lengthen Acceleration Lane

  The acceleration lane at this exit would be increased from its existing length of 900 feet to the required length of 1,420 feet. The 520-foot extension would be created by means of pavement re-striping.

Limits of Proposed Improvement on Route 125 NB (Exit 51) in Haverhill



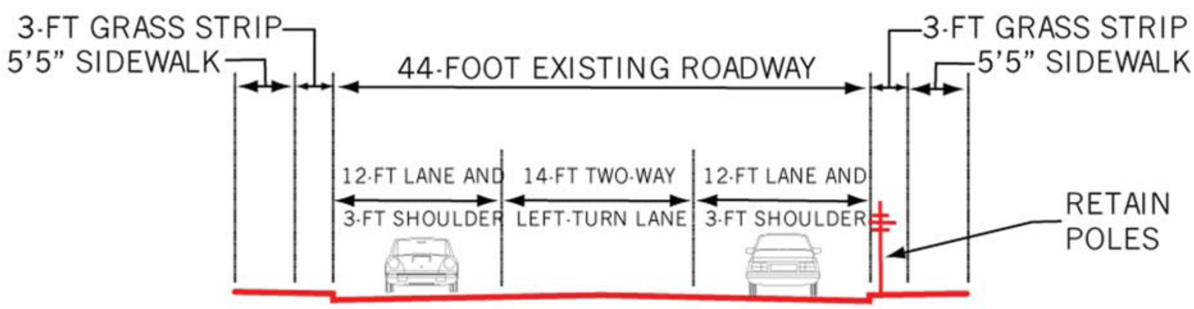
Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

Existing Conditions on Route 125 NB (Exit 51) in Haverhill

Figures 4-15a – 4-15b
Limits of Proposed Improvement on Route 125 NB (Exit 51) in Haverhill
Existing Conditions on Route 125 NB (Exit 51) in Haverhill

Existing Conditions (continued) on Route 125 NB (Exit 51) in Haverhill

Existing Roadway Cross-Section on Route 125 NB (Exit 51) in Haverhill



Proposed Roadway Cross-Section on Route 125 NB (Exit 51) in Haverhill

Approximate Cost = $590,000

Figures 4-16a – 4-16c
Existing Conditions on Route 125 NB (Exit 51) in Haverhill
Existing and Proposed Roadway Cross-Section on Route 125 NB (Exit 51) in Haverhill

Exit 54 (NB)/State Route 150 (Hillside Avenue) in Amesbury

- Lengthen Deceleration Lane

  In order to achieve the required length of 530 feet, the existing 280-foot deceleration lane would be lengthened by 250 feet using pavement re-striping.

Exit 55 (NB)/State Route 110 (Macy Street) in Amesbury

- Install Traffic Signal System (Route 110 Widened by Others)

  A traffic signal system here would improve the left-turn movement at the end of the off-ramp from LOS F to LOS B during the AM peak hour. Average delay for this movement would be reduced from 217 seconds to 16 seconds. Level of Service would also be improved from LOS F to LOS B during the PM peak hour as a result of the proposed traffic signal installation. During this time period, average delay would be reduced from 138 seconds to 19 seconds.

  Figure 4-17 illustrates existing conditions at this location and the potential improvements.

Junction of I-495 with I-95

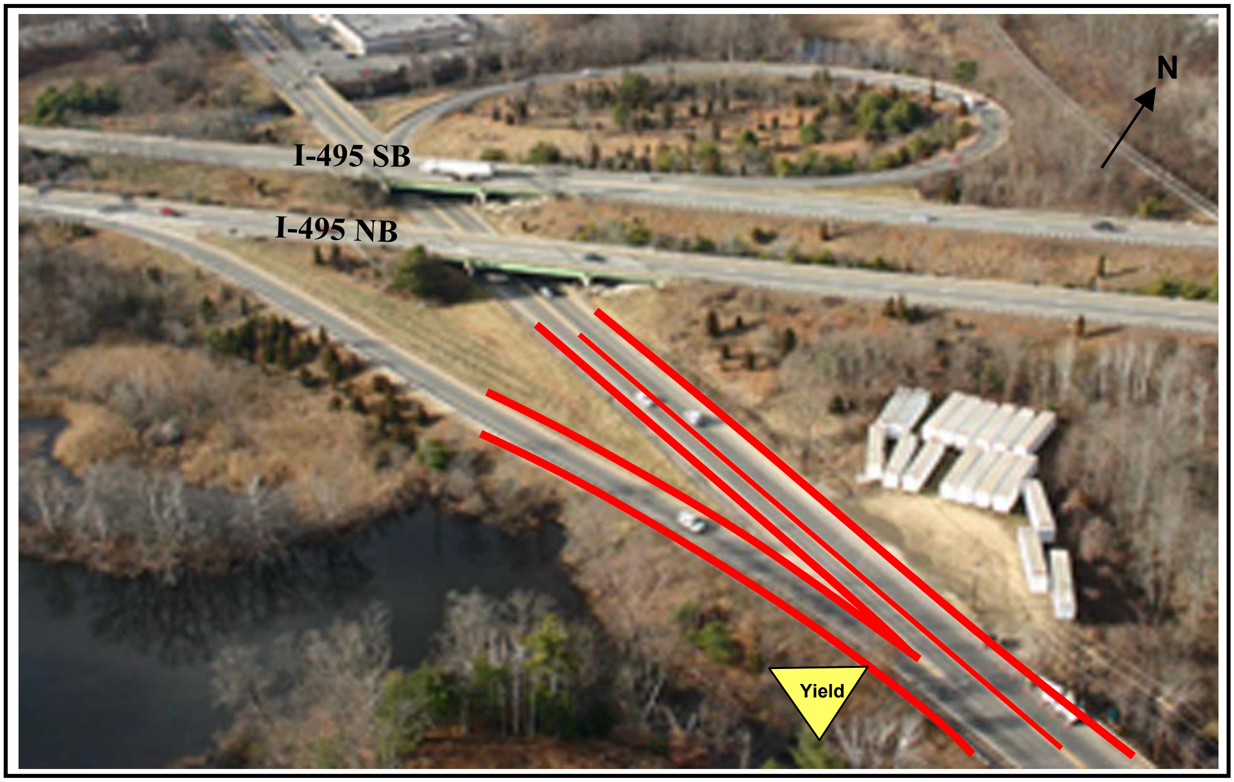
- Study Feasibility of Full Interchange at this Location

  It is proposed that a study be undertaken to examine the feasibility of instituting a full interchange at this location. Specifically, the existing interchange design does not allow for movements from I-495 north to I-95 south and from I-95 north to I-495 south. Such movements presently have to be accomplished via State Route 110. The study would examine the feasibility of adding new ramps between the two Interstate highways necessary to make those missing connections, potentially voiding the need for the use of State Route 110 by vehicles attempting to make these two missing direct connections. Removal of this traffic from State Route 110 would help to alleviate congestion problems on that roadway.

4.5 Potential Long-Term Improvements (More Than 8 Years)

In this section, potential Long-Term improvement projects are discussed. These projects include adding mainline travel lanes along portions of I-495 for the purpose of increasing the highway's capacity, improvements

Exit 55 NB at Route 110 in Amesbury (Existing)



Exit 55 NB at Route 110 in Amesbury (Proposed)

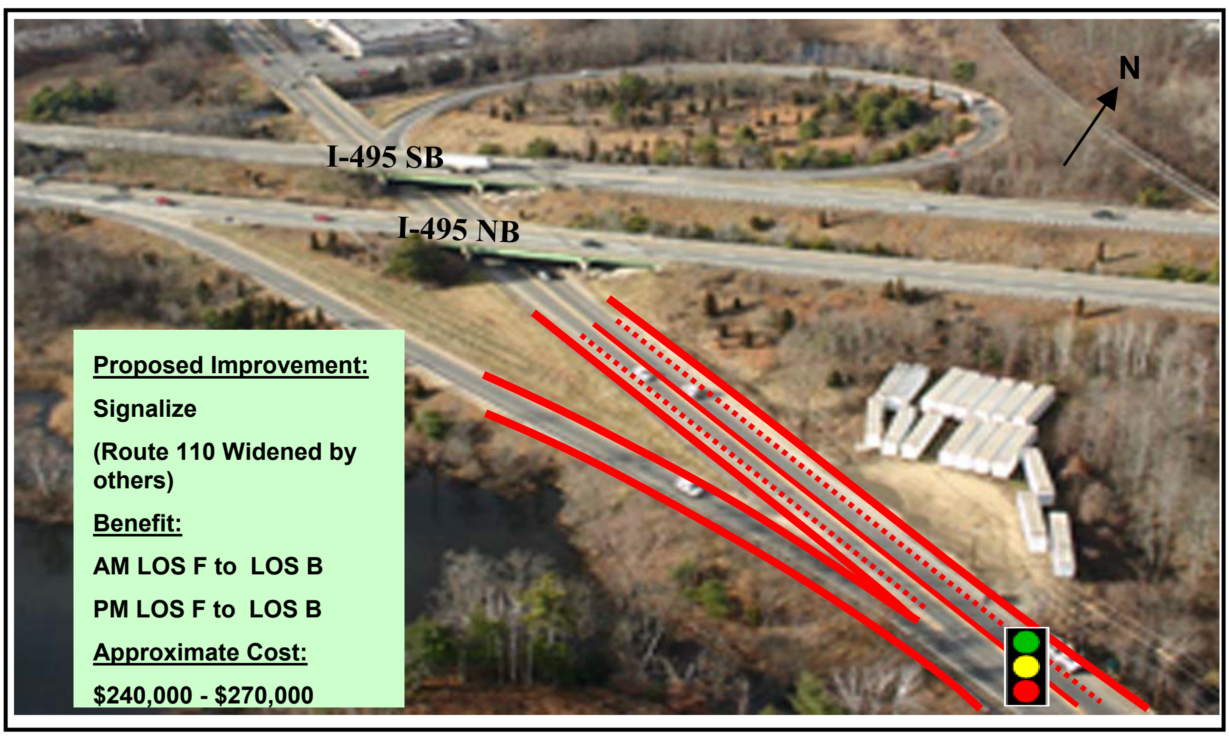


Figure 4-17
Existing Condition and Proposed Improvement at Exit 55 NB and Route 110 in Amesbury

at an interchange, the retiming of several traffic signal systems, and the installation of traffic signal systems at three new locations. Figures 4-4 and 4-5 indicate the locations of potential Long-Term improvements at intersections.

Potential long-term improvements are all responses to expected future problems that do not presently exist. With one exception, they are not of the type that could be carried out under MassHighway District maintenance contracts, as they all involve new construction of some type. The one exception is a traffic signal retiming effort at one location. Long-term improvements involving the installation of new traffic signal systems would not likely result in environmental impacts. However, the addition of more travel lanes to a portion of I-495 could be expected to result in substantial impacts to the environment and would have to comply with the requirements of the Massachusetts Environmental Policy Act (MEPA) and the National Environmental Policy Act (NEPA). It should be noted, however, that Mass GIS data would appear to indicate that the potential intersection capacity improvements at Exit 32 in Westford and the potential traffic signal installation improvement at Exit 49 in Haverhill might be located within the buffer zone of a protected resource. Accordingly, coordination with the Conservation Commissions in those two communities will be required if this is later confirmed.

4.5.1 I-495 Mainline Improved Operations

As presented on Figures 3-15 through 3-18, there are numerous sections of the I-495 mainline that will operate at LOS E or LOS F in one or both peak hours by 2030. The proposed solution for these conditions is to increase mainline capacity in these sections by the addition of one additional travel lane in each direction. Based on projected traffic volume, this improvement will create LOS D or better peak hour conditions throughout the I-495 corridor. Figures 4-18 and 4-19 illustrate the sections of I-495 proposed for eventual widening.

As this study is based on the single future year of 2030, it is difficult to identify the point in time at which mainline operations change from 2006's LOS D or better to 2030's LOS E or F. Clearly, anticipating this change and beginning the implementation process for a widening of I-495 in time to minimize the number of years that less than LOS D operations occur is a long-term goal.

As a frame of reference, it is anticipated that at least 8-12 years would be necessary to conduct the major NEPA and MEPA environmental documentation efforts needed to win approval to widen I-495, complete design efforts, and actually construct the additional lane. So, at a minimum, work to advance the widening would need to start by 2018 to have the improvement in place no later than 2030.

However, future traffic volumes may not increase at the rate anticipated in this study. Consequently, the actual rate of future year traffic volume growth should be monitored on an annual basis. Accordingly, the corridor's two regional planning agencies should plan to conduct an on-going program of monitoring traffic volume growth on I-495. Should traffic be found to be growing faster that assumed in this study, the implementation time for the long-term improvement may have to be accelerated.

4.5.2 I-495 Ramp Intersections with Local Street Improved Operations

With the exception of two turning movement in the 2030 PM peak hour at the intersections of Exit 39 SB and State Route 133 and Exit 41 SB and State Route 28, all the study-area's intersection movements will operate at LOS D or better in 2030 following implementation of improvements proposed in this study. This is shown on Figures 4-20 through 4-23. Location-by-location operational analyses are presented in Appendix D.

4.5.3 I-495 Merge and Diverge Improved Operations

As illustrated on Figures 4-24 through 4-27, of the 89 merge and diverge locations evaluated in this study, all but 6 will operate at LOS D or better in 2030 AM as well as in the PM peak period following the widening of the I-495 mainline. The six locations that are projected to operate at LOS F are the merges at Exit 36 NB, Exit 45 NB, Exit 51 SB, Exit 56 NB to I-95 and the diverges at Exit 36 SB, Exit 43 NB and SB, Exit 45 SB, Exit 50 SB, and Exit 56 from I-95. All LOS F locations are outside the sections of I-495 proposed for widening. Given that the I-495 mainline operates at LOS D or better at these locations, and that widening is the only solution to improving poor merge and diverge operations, it is proposed that these locations be revisited as part of the future study of widening I-495.

Additionally, it is recommended that the failing merge and diverge movements to and from I-95 and I-495 be evaluated for solutions in the Full Interchange Feasibility Study recommended previously.

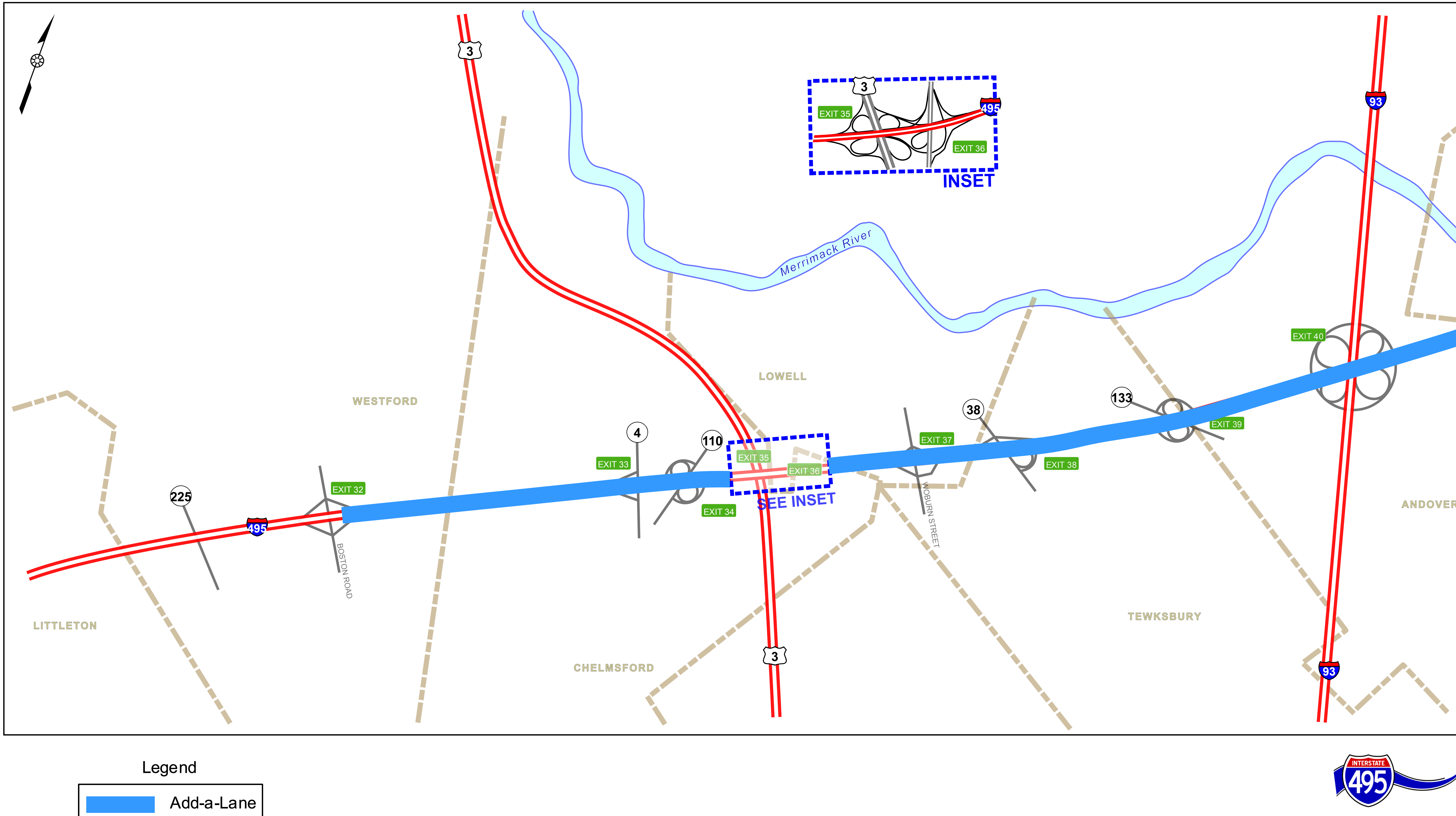
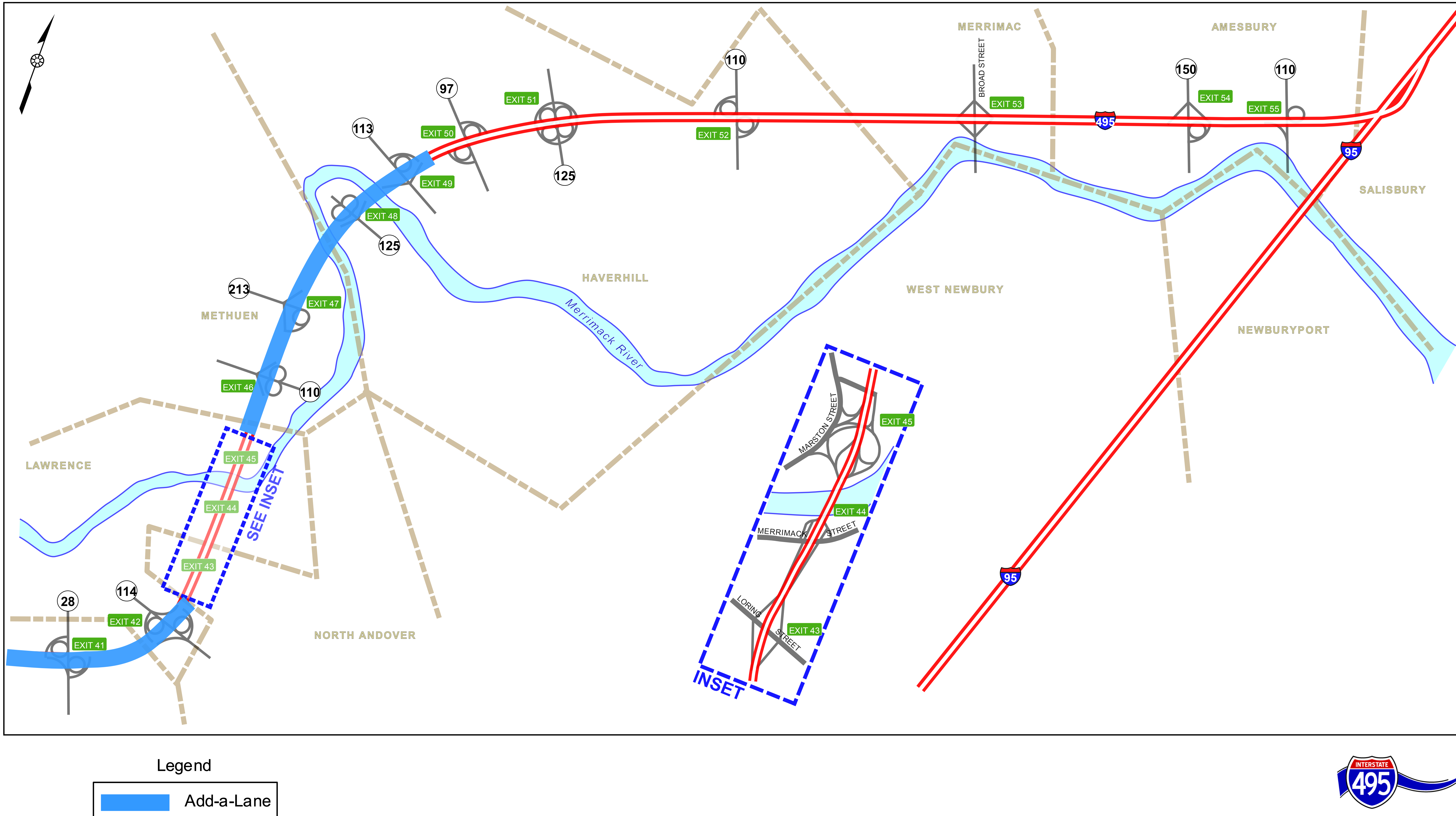


*Figure 4-18

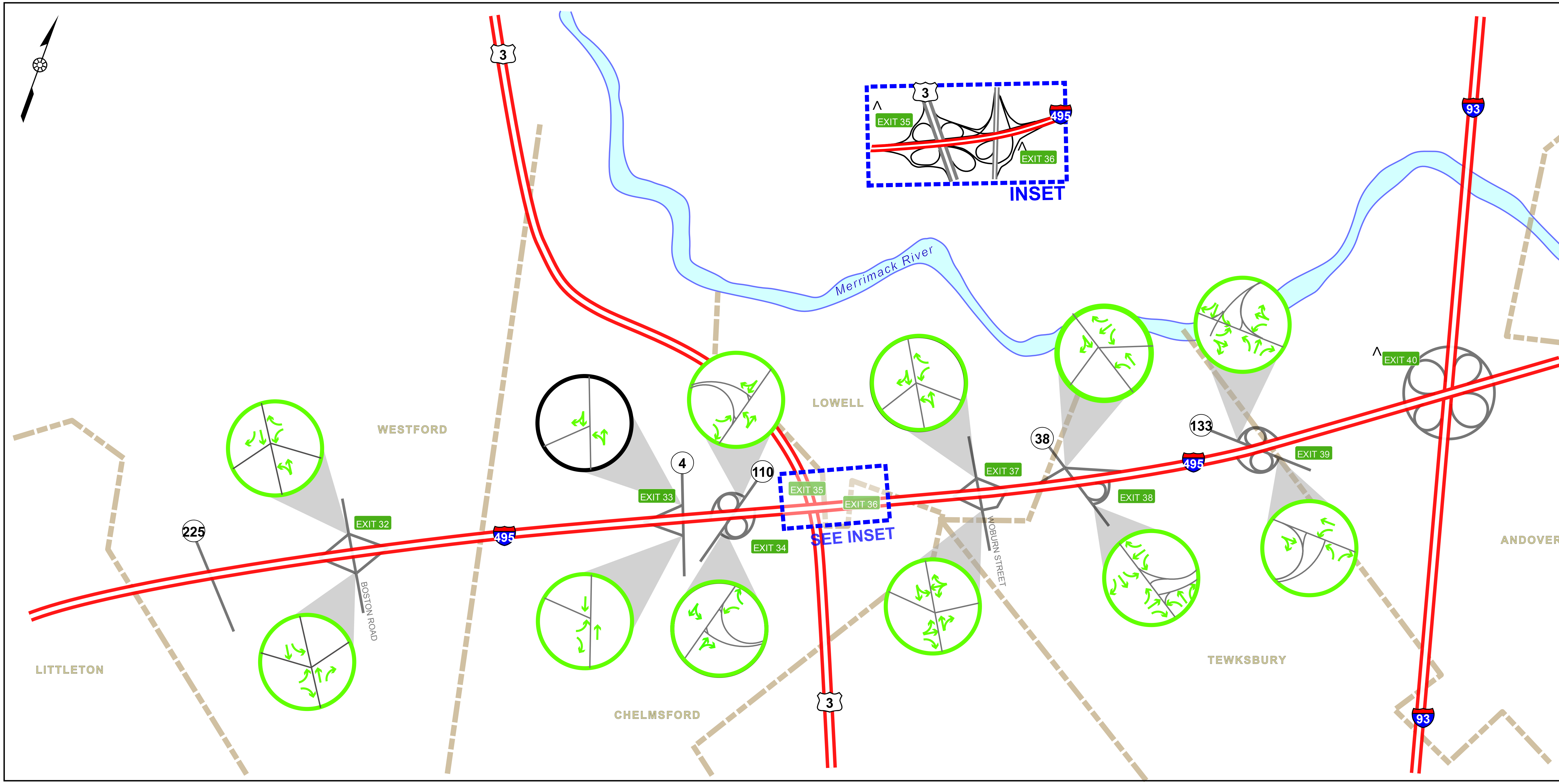
Limits of Western Segment Add-a-Lane Improvement

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

*Figure 4-19
Limits of Eastern Segment Add-a-Lane Improvement

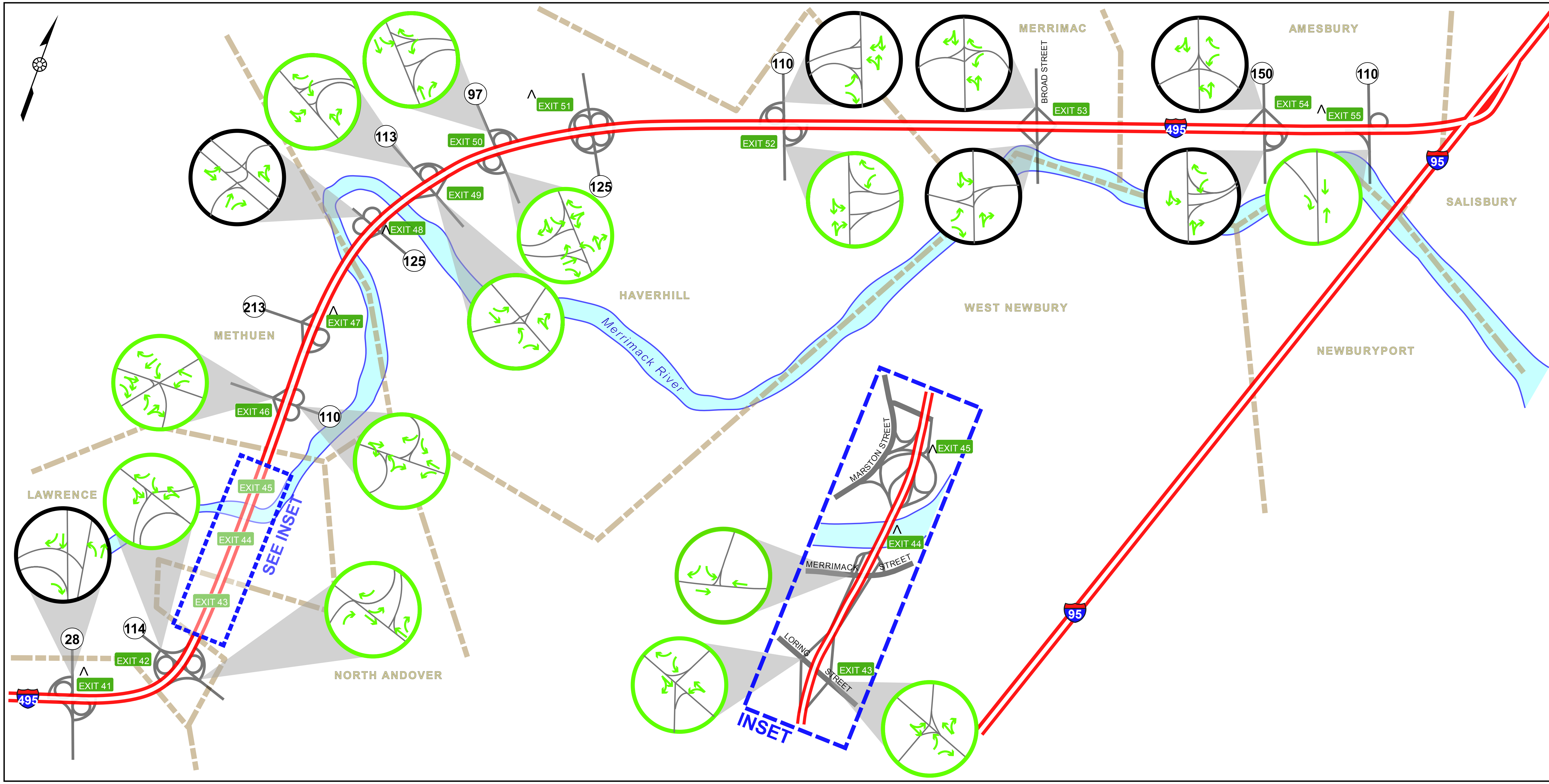


Legend

- Signalized Intersection - Overall intersection LOS shown by color of circle
- Unsignalized Intersection - Overall intersection LOS not applicable
- LOS A - D
- LOS E
- LOS F
- ^ Refer to Figure 4-25 for ramp operations

Figure 4-20*
2030 AM Build with Improvements Peak Hour LOS Intersection Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

LOS E

LOS F

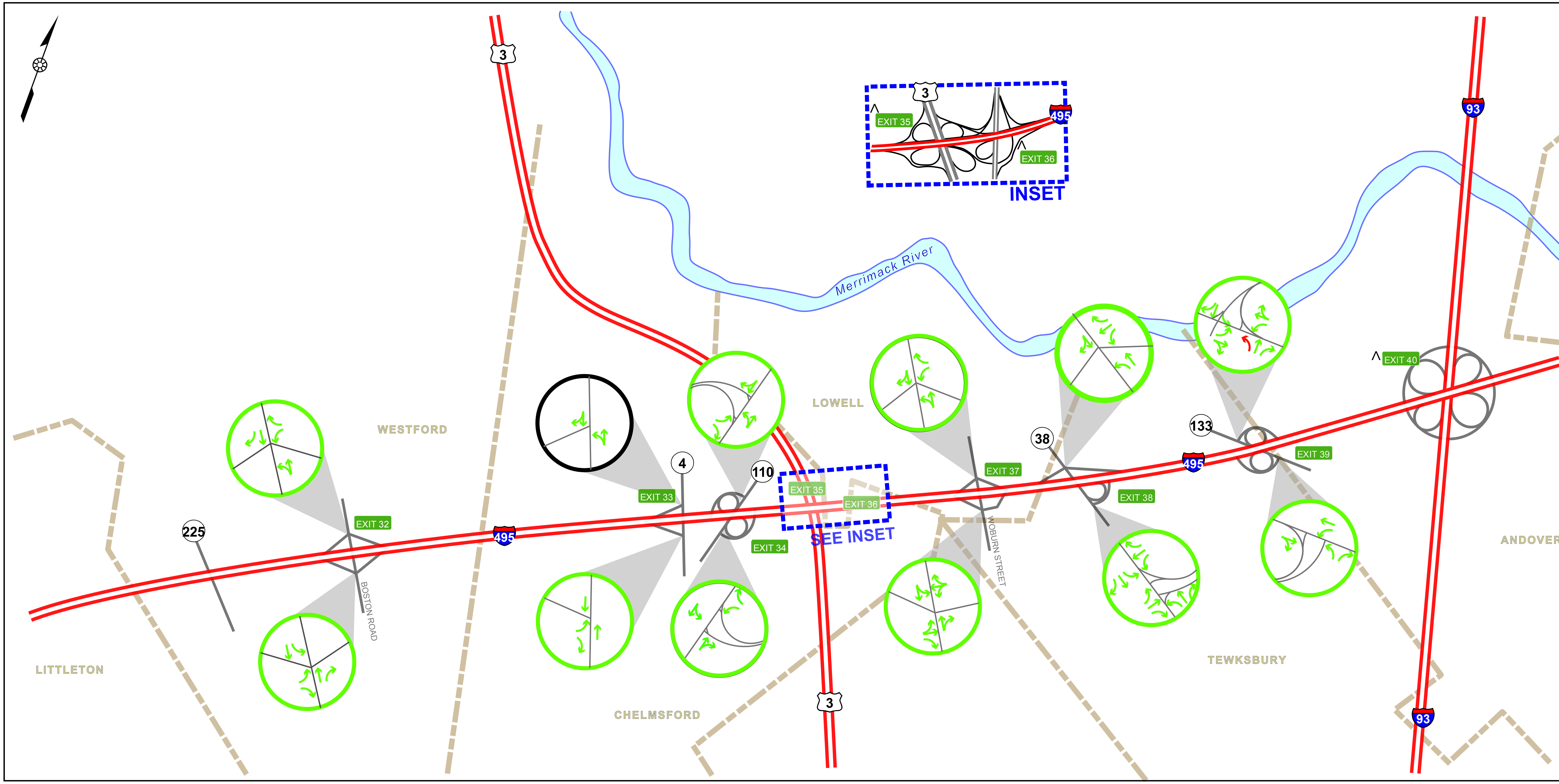
^ LOS was only calculated for intersections with stop and signal control

Figure 4-21*

2030 Build with Improvements AM Peak Hour LOS Intersection Operations

Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

LOS E

LOS F

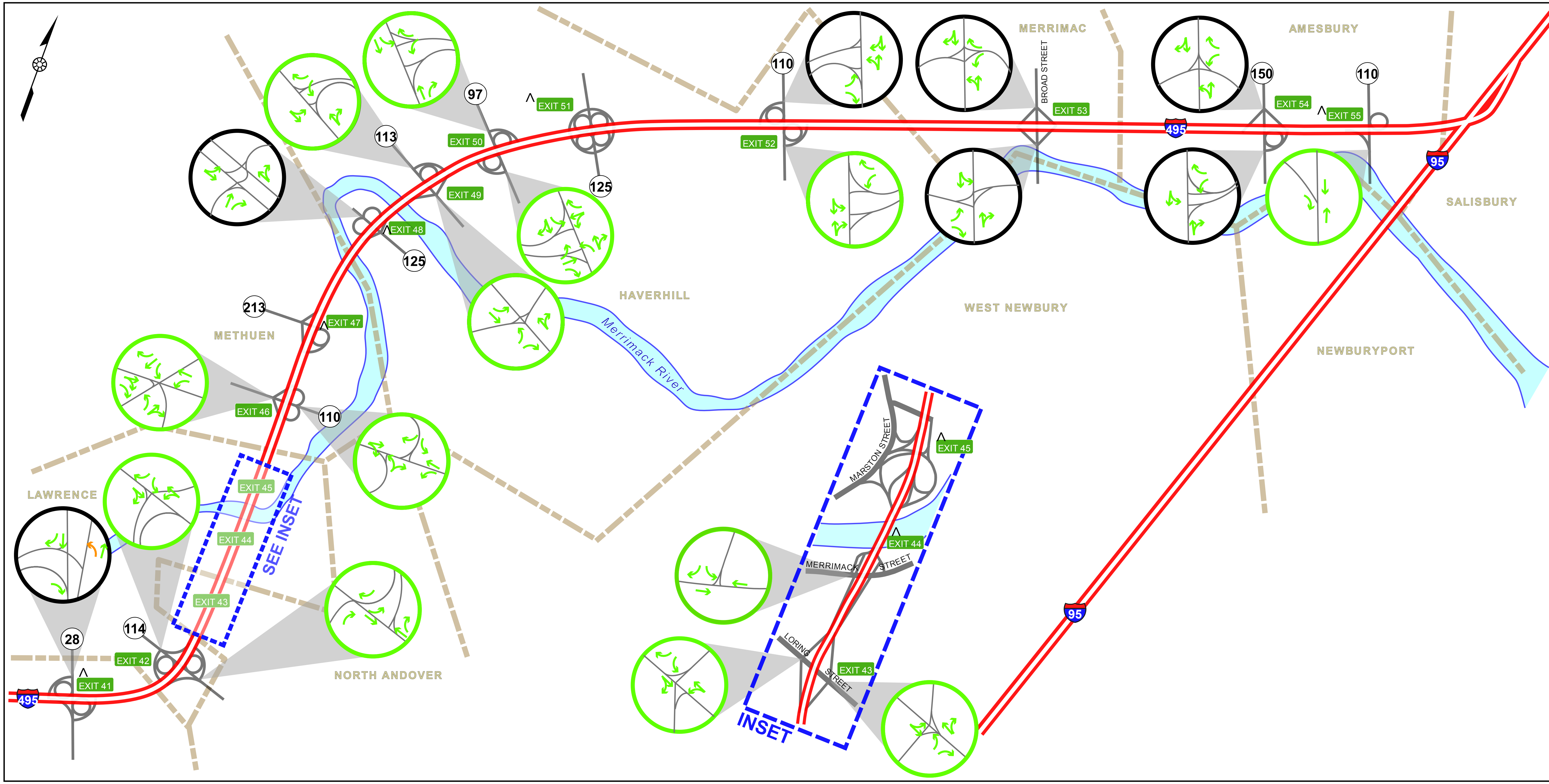
^ Refer to Figure 4-27 for ramp operations

Figure 4-22*

2030 PM Build with Improvements Peak Hour LOS Intersection Operations

Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

Signalized Intersection - Overall intersection LOS shown by color of circle

Unsignalized Intersection - Overall intersection LOS not applicable

LOS A - D

LOS E

LOS F

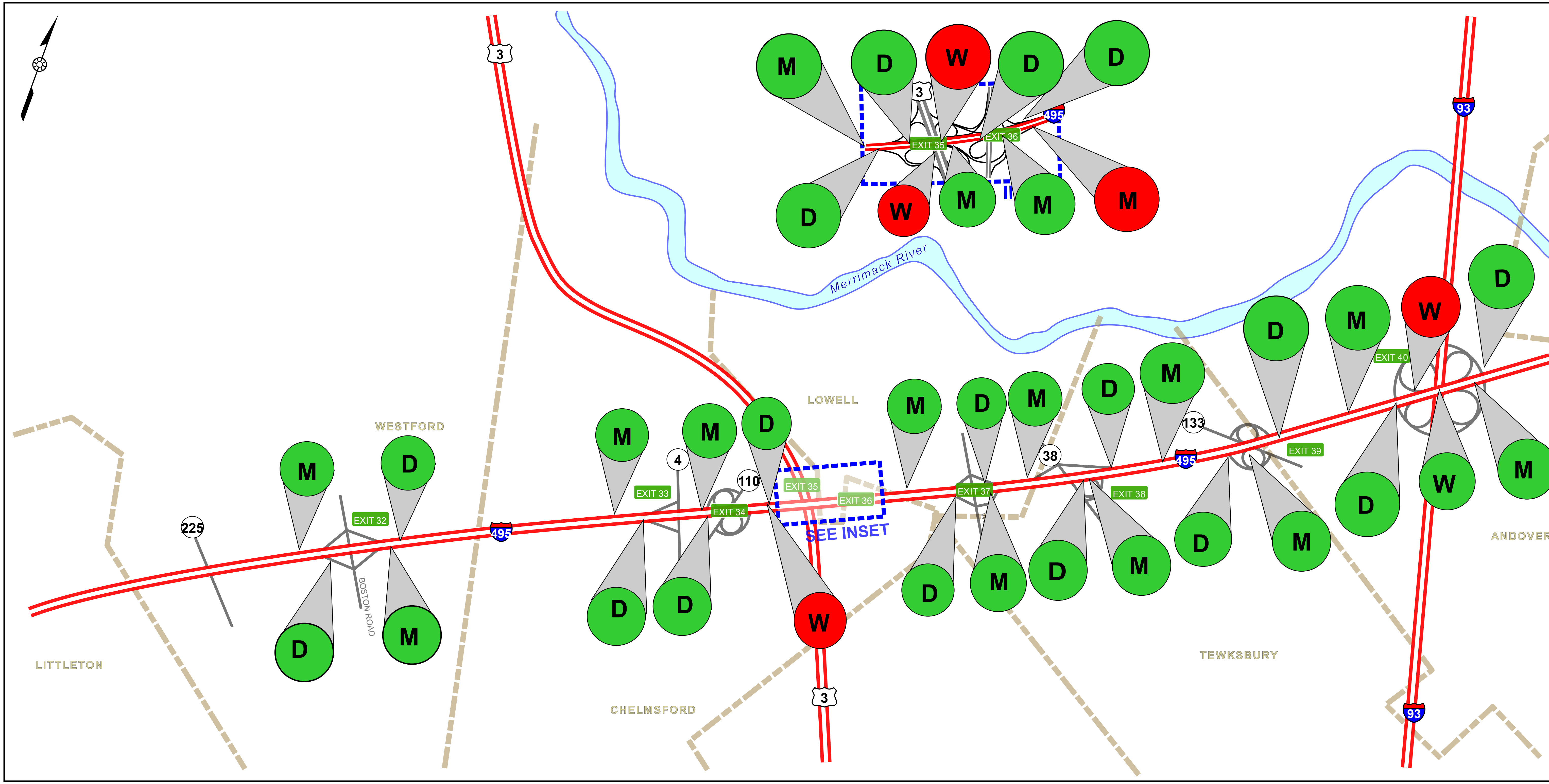
^ LOS was only calculated for intersections with stop and signal control

Figure 4-23*

2030 Build with Improvements PM Peak Hour LOS Intersection Operations

Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

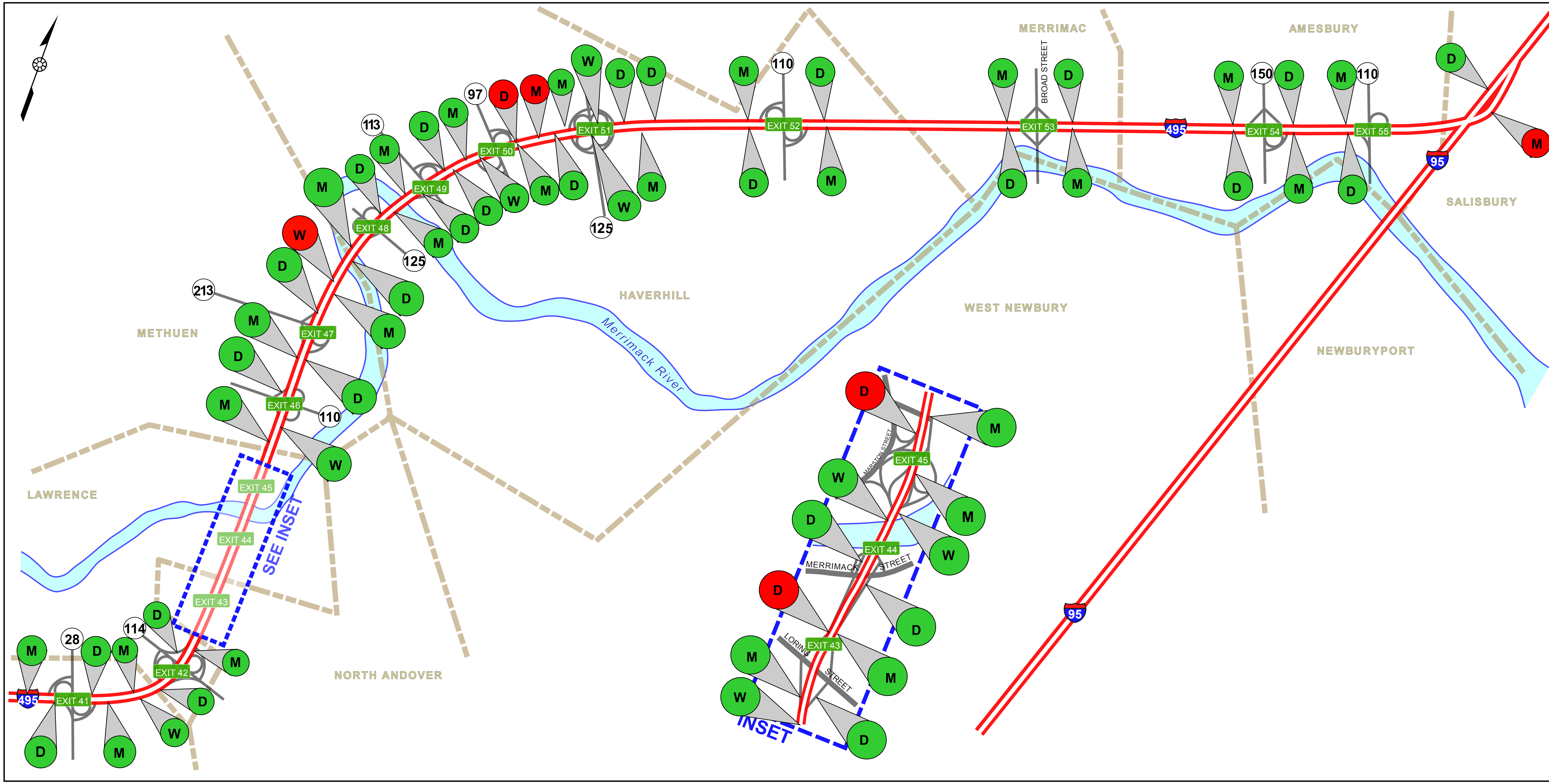


Legend

	LOS A - D	**D**	Diverge
	LOS E	**M**	Merge
	LOS F	**W**	Weave

Figure 4-24*
2030 Build with Improvements AM Peak Hour Ramp Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Emergy and Environmental Affairs



Legend

	LOS A - D	D	Diverge
	LOS E	M	Merge
	LOS F	W	Weave

Figure 4-25*
2030 Build with Improvements AM Peak Hour Ramp Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

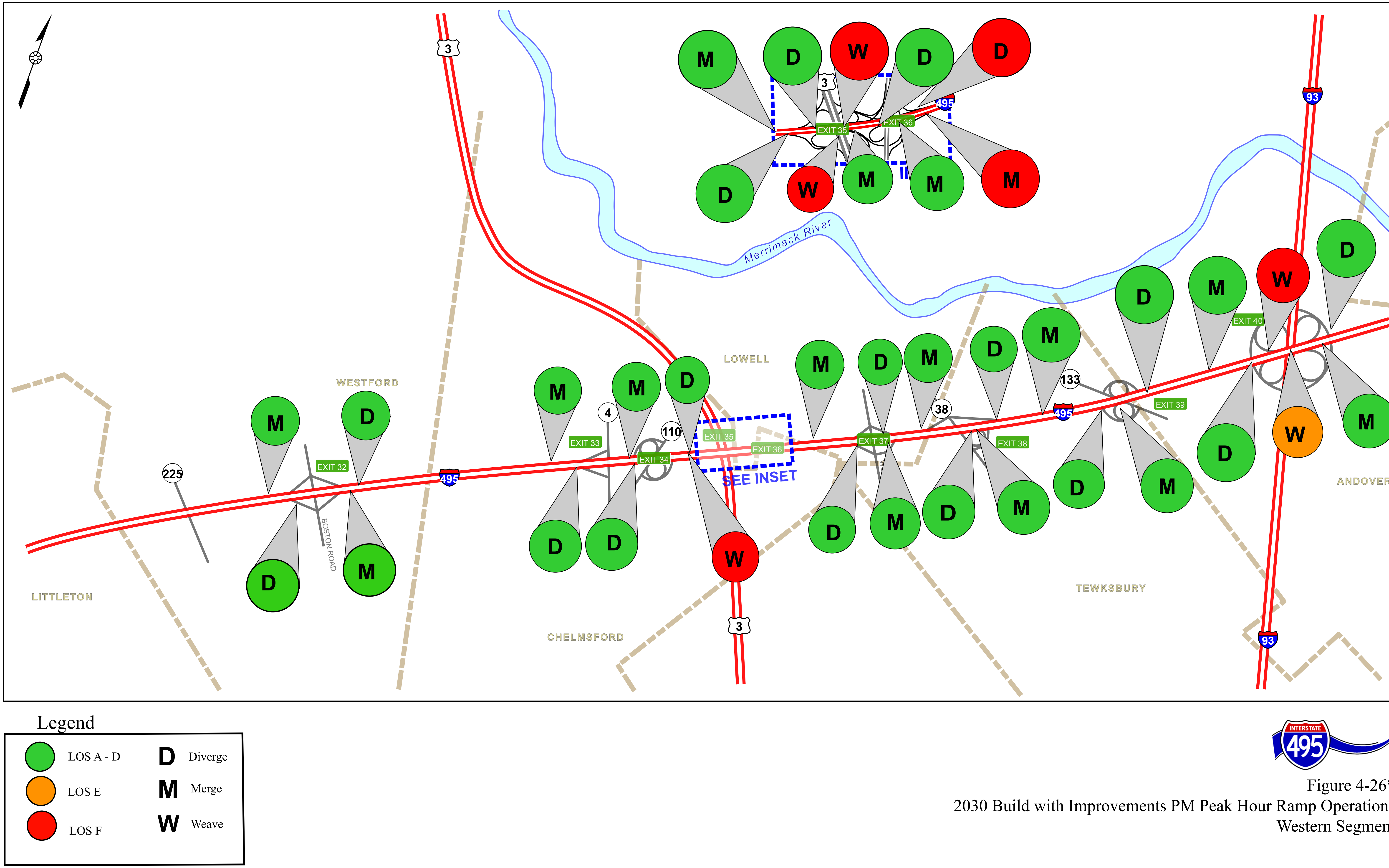
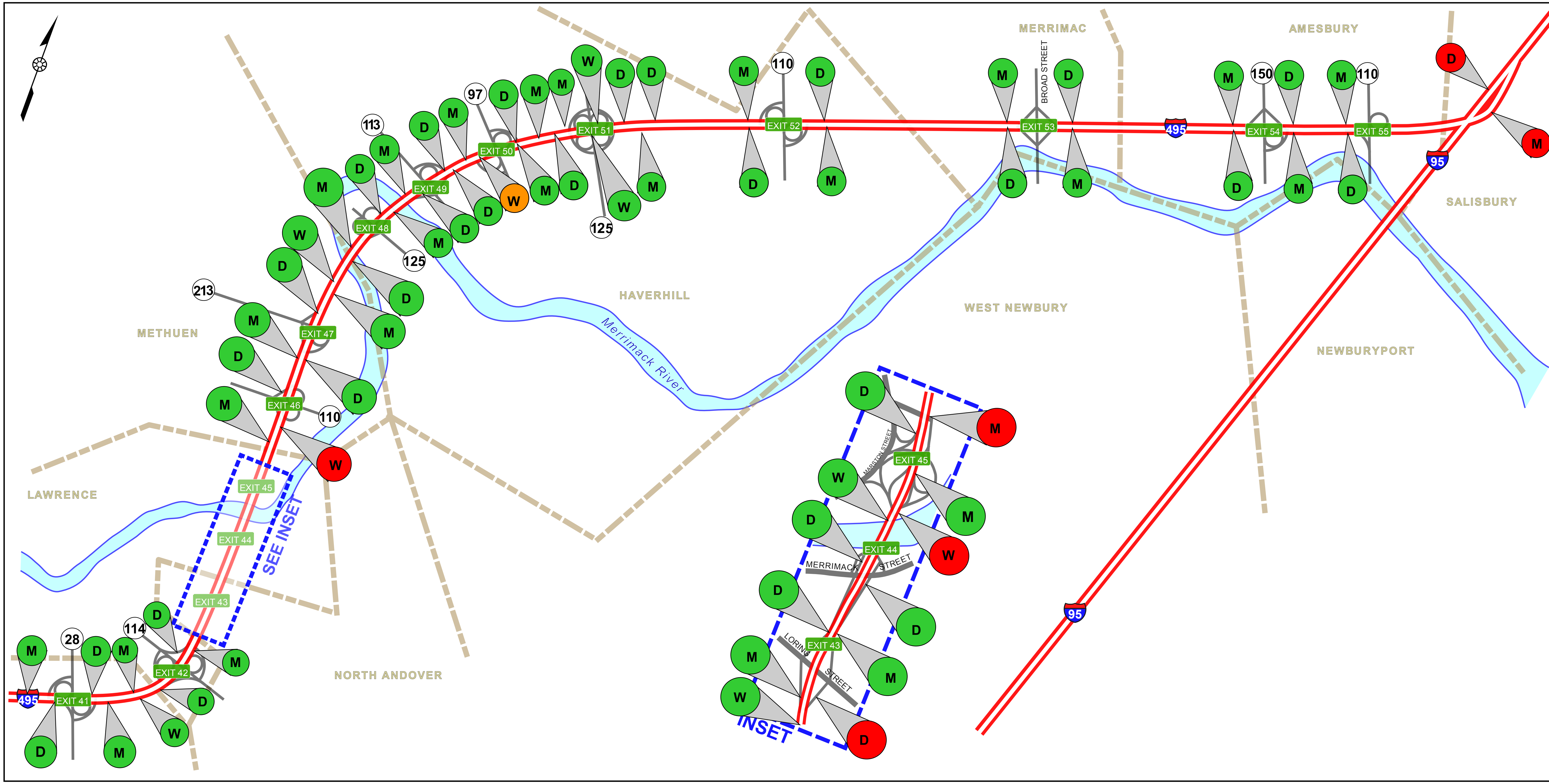


Figure 4-26*
2030 Build with Improvements PM Peak Hour Ramp Operations
Western Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs



Legend

(green)	LOS A - D	**D**	Diverge
(orange)	LOS E	**M**	Merge
(red)	LOS F	**W**	Weave

Figure 4-27*
2030 Build with Improvements PM Peak Hour Ramp Operations
Eastern Segment

*Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs

4.5.4 I-495 Weave Operations

Figures 4-24 through 4-27 illustrate that, of the 14 total weave locations in the study area, 5 are projected to operate at LOS F in the 2030 AM peak hour and 8 are projected to operate at LOS E or F in the 2030 PM peak hour.

These problematic weaving movements involving I-495 traffic occur at Exits 35, 36, 40, 45, 46, and 48, which are all full or partial cloverleaf interchanges.

As discussed in Chapter 2, the determining factors for the quality of weaving operations involve the distance allowed for the weave to occur and the volume of traffic weaving within that distance. Because the cloverleaf design by its nature results in successive on- and off-ramps in relatively close proximity to each other, it is difficult to maintain acceptable levels of service once traffic demands exceed a tipping point. In the case of these locations, by 2030 demand to traverse the weave area will exceed the capacity of the weaving distance provided. Even lengthening the distance provided for weaving at these Exits will not address the less-than-LOS D operations projected for these locations. Consequently, the ultimate solution for these locations is the complete redesign of the involved interchanges such that cloverleaf designs (that require weaving movements) are eliminated.

Specifically regarding one of these locations, the interchange of I-495 with I-93 at Exit 40, the Merrimack Valley Planning Commission has completed the I-93 Corridor Study that identifies operational issues on I-93 similar to those identified in this study on I-495. That study recommends, “that an improvement at this interchange is needed and should be made.”

Revised designs for cloverleaf interchanges could, depending on location, involve collector-distributor roads, relocated interchanges, flyovers, or other totally different types of designs than these interchange locations exhibit today. Clearly, these are major improvements requiring tens of millions of dollars for construction, likely property acquisition, and potentially major environmental impacts. Identifying the most feasible solutions will involve future studies that focus on these specific locations. In some cases, these interchange studies can be undertaken as part of the study to widen sections of I-495. In the case of Exit 40, it could be that this location will be studied as part of a future study to widen I-93. For Exit 51, which is beyond the section of I-495 proposed for widening, it is possible that a stand-alone interchange study be conducted to identify solutions for this location’s 2030 weaving problems.

4.5.5 Western Segment

Mainline

- Add an Additional Travel Lane in Each Direction from Exit 32 to Exit 40, Exclusive of Between Exits 35 and 36.

  The total distance along the Western Segment of I-495 that would be widened is approximately 15 miles, with the location shown on Figure 4-18. All widening would occur in the highway's median. All widened links would operate at LOS B, LOS C, or LOS D during both the AM and PM peak hours and in both the eastbound and westbound directions of I-495.

  In addition, following completion of the roadway widening, all merge and diverge movements at I-495's interchanges in the Western Segment would operate at LOS B, LOS C, or LOS D during both the AM and PM peak hours. However, during the AM peak hour, two weave movements would continue to experience LOS F conditions, these being the weave movement from I-495 NB to State Route 110/U.S. Route 3 and the weave movement from I-495 SB to I-93. During the PM peak hour, there would be three such weaving movements at LOS F or LOS E, specifically the same two movements as during the AM peak hour along with the weave movement from I-495 NB to I-93. Providing additional mainline travel lanes would not be effective in improving the level of service associated with weaving movements. Only the relocation or major redesign of the interchanges to provide longer weaving distances could address this problem.

  It is important to recognize that the western boundary of this I-495 Corridor Transportation Study was Exit 32 in Westford. Analysis has shown there to be LOS E or LOS F link operating conditions to the east of this interchange in the future. It is likely that the same or similar conditions will continue to the west of Exit 32, perhaps to State Route 119 or even to State Route 2. When, in the future, the need to widen I-495 from three travel lanes to four in each direction is examined in more detail, the need for extending this widening to the west of Exit 32 should be considered.

Exit 32 (SB)/Boston Road in Westford

- Capacity Improvements

  The potential improvement here would be to physically add an additional lane for the right-turn movement at the end of the off-ramp and to change the control of this movement from a free right to a signalized movement. During the AM peak hour, the level of service for this movement will improve from LOS F to LOS D, with an associated reduction in average delay from 92 seconds to 38 seconds. The PM peak hour will see intersection LOS remain at LOS B.

  Existing conditions and improvements considered for this location are given on Figure 4-28.

Exit 38 (NB)/State Route 38 in Tewksbury

- Retime Existing Traffic Signal System

  The retiming of the traffic signal system at this location would have very minimal effects on intersection level of service for the AM peak hour analysis period. However, for the PM peak period, improvements in LOS would result. Specifically, the exit ramp's left-turn and right-turn movements, as well as the ramp as a whole, would all operate at LOS E without any changes to the existing signal timing. With changes, LOS in each case would improve to LOS D. There would also be commensurate reductions in average delay. The queue length associated with the left-turn movement would experience a substantial decrease in length, from 253 feet to 33 feet. An identical situation would also occur for the left-turn movement into the intersection from the Home Depot driveway, with LOS improving from LOS E to LOS D.

4.5.6 Eastern Segment

Mainline

- Add an Additional Travel Lane in Each Direction from Exit 40 to Beyond Exit 49, excluding from Before Exit 43 to Just Beyond Exit 45.

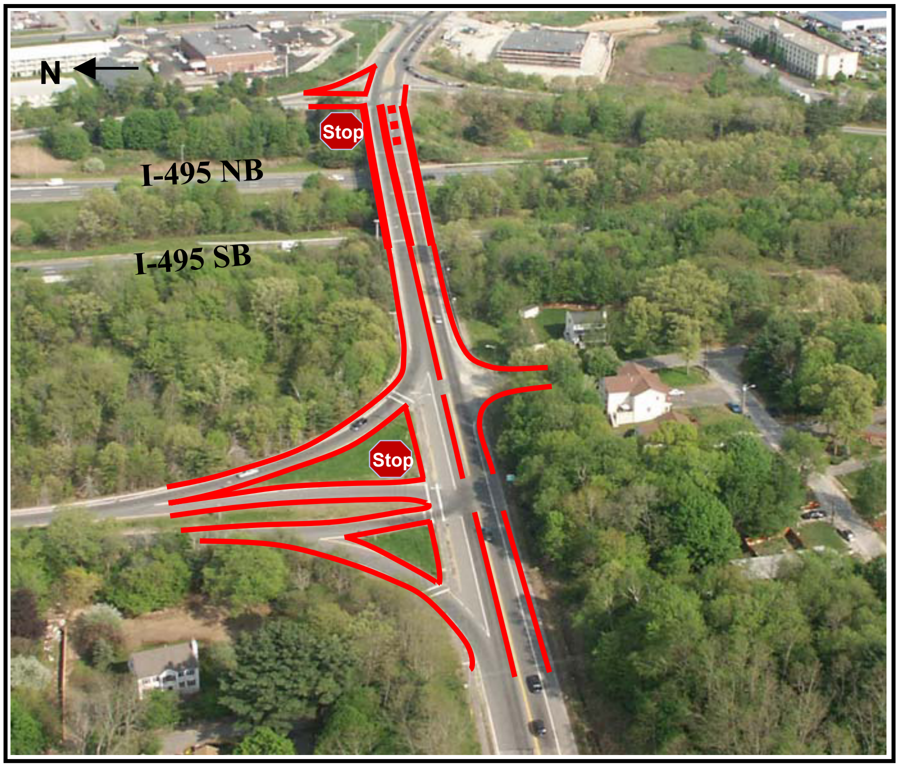
  The total distance to be potentially widened is approximately 7 miles along I-495, as shown on Figure 4-29. All widened links would operate at LOS B, LOS C, or LOS D during both the AM and PM peak hours and in both the eastbound and westbound directions.

Exit 32 NB at Boston Road in Westford (Existing)

Exit 32 NB at Boston Road in Westford (Proposed)

Figure 4-28
Existing Condition and Proposed Improvement at Exit 32 NB and Boston Road in Westford

Exit 49 NB and SB at Route 110/113 in Haverhill (Existing)



Exit 49 NB and SB at Route 110/113 in Haverhill (Proposed)

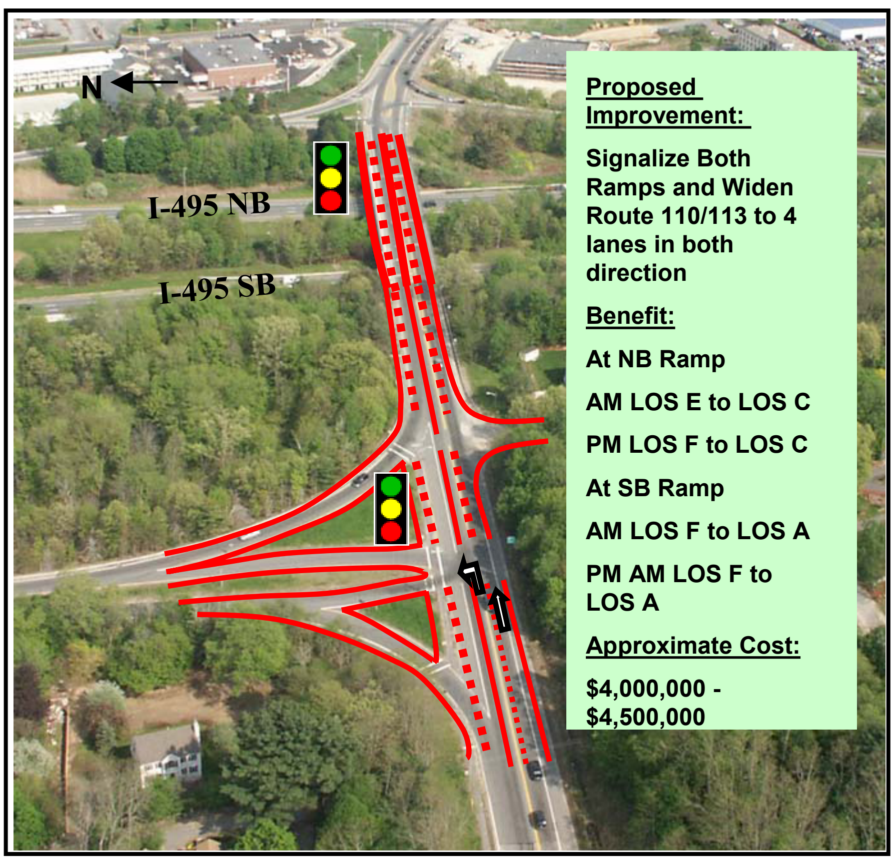


Figure 4-29
Existing Condition and Proposed Improvement at Exit 49 NB and SB and Route 110/113 in Haverhill

Widening the roadway would also result in all merge and diverge movements along the Eastern Segment operating at LOS B, LOS C, or LOS D during both the AM and PM peak hour analysis periods. Similar to the situation described for the Western Segment, one weave movement along this section would operate at LOS F during both the AM and PM peak hours. For the AM peak hour, the specific weave movement would be the I-495 SB weave to the State Route 125 Connector at Exit 48, while that for the PM peak hour would be the I-495 NB weave to State Route 110 at Exit 46.

Again, only major redesign of the interchanges could help to resolve these identified weave problem areas.

As noted, the potential widening of mainline I-495 in the Eastern Segment does not include that section of the roadway from just before Exit 43 to just after Exit 45, including the double-decker bridge over the Merrimack River. Analyses have shown that the roadway links between Exits 43 and 45 will operate at LOS D or better in 2030 without widening. However, it is recognized that "traffic turbulence" could possibly develop at the point in each direction where the highway would change in cross-section from four travel lanes to three. Potential ways to minimize or eliminate this turbulence need to be studied further. One potential solution might be, for example, to have the far right travel lane (out of the four in the cross-section) be signed as "exit-only" approaching Exit 43. In this configuration, rather than requiring drivers to merge prior to dropping the fourth lane, the fourth lane ends as the exit lane. Through traffic continues without having to merge from four to three travel lanes. The remaining three travel lanes would continue on beyond Exit 43, with the cross-section widening back to four travel lanes beyond Exit 45. As mentioned, the Eastern Segment is highly directional with the largest volume traveling westbound in the AM and eastbound in the PM. Approximately 1,200 vehicles exit I-495 eastbound in the PM peak at Exit 43. Similarly, in the AM peak hour, approximately 1,200 westbound vehicles exit I-495 at Exit 45. It is these decreases in volume prior to the double-decker bridge that accounts for the bridge's three lanes providing LOS D in 2030 peak hours. By utilizing the Exits 43 and 45 exit lanes as the location to drop the fourth lane, a major merge of traffic from four lanes to three lanes is minimized by the high volume of exiting traffic. Similarly, by utilizing these Exits on ramps as the start of the fourth lane high volumes of traffic entering I-495 will enter in an on ramp that becomes a fourth lane.

Alternatively, when the possible widening of I-495 is studied in the future in more detail than possible in this study, consideration could be given to maintaining the four-lane cross-section throughout. Such a course of action would involve replacing the double-decker bridge between Exits 43 and 45, at a cost that could approach the estimated cost of widening the Eastern Segment as proposed in this study.

Exit 46 (NB)/State Route 110 in Methuen

- Retime Existing Traffic Signal System

For the PM peak hour period, the exit ramp's combined left/through movement and the exit ramp as a whole would see their level of service improve from LOS F to LOS C and LOS B, respectively. For the left/through off-ramp movement, average delay would decrease from 264 seconds to 29 seconds. Average delay for the exit ramp as a whole would decrease from 181 seconds to 20 seconds. Level of service for the intersection as a whole would decline slightly from LOS A to LOS B.

Exit 49 (NB)/State Routes 110/113 (River Street) in Haverhill

- Install Traffic Signal System

During the AM peak hour, the installation of a traffic signal system at this location would improve the left-turn movement at the end of the off-ramp from LOS F to LOS A, at the same time providing a reduction in average delay for this movement from 461 seconds to 9 seconds. For the right-turn movement at the end of the off-ramp, level of service would be improved from LOS F to LOS D. The corresponding reduction in average delay would be from 466 seconds to 47 seconds. For the PM peak hour, the left-turn movement would see its level of service improve from LOS F to LOS B, with average delay changing from 192 seconds to 19 seconds. The right-turn movement would operate at LOS C with or without a signal system and with delays of approximately 20 seconds in either case.

Existing conditions at this intersection and the potential improvements are illustrated on Figure 4-29.

Exit 49 (SB)/State Routes 110/113 (River Street) in Haverhill

- Install Traffic Signal System

Here, the installation of a traffic signal system would provide its most meaningful benefit during the PM peak hour. Specifically, level of service for the left-turn movement at the end of the off-ramp would improve from LOS F to LOS A, with average delay reducing from 85 seconds to 8 seconds. Operations during the AM peak hour would be at LOS D or better with or without a signal.

Figures 4-29 illustrate this location under existing conditions and with improvements, respectively.

Exit 52 (NB)/State Route 110 (Amesbury Road) in Haverhill

- Install Traffic Signal System

The installation of a traffic signal system at this location would, during the AM peak hour, result in an improvement in level of service for the left-turn movement at the end of the off-ramp from LOS F to LOS B. Consequently, average delay for this movement would be reduced from 147 seconds to 12 seconds. During the PM peak hour, conditions for this same movement would improve from LOS E to LOS B, with a reduction in average delay from 39 seconds to 12 seconds.

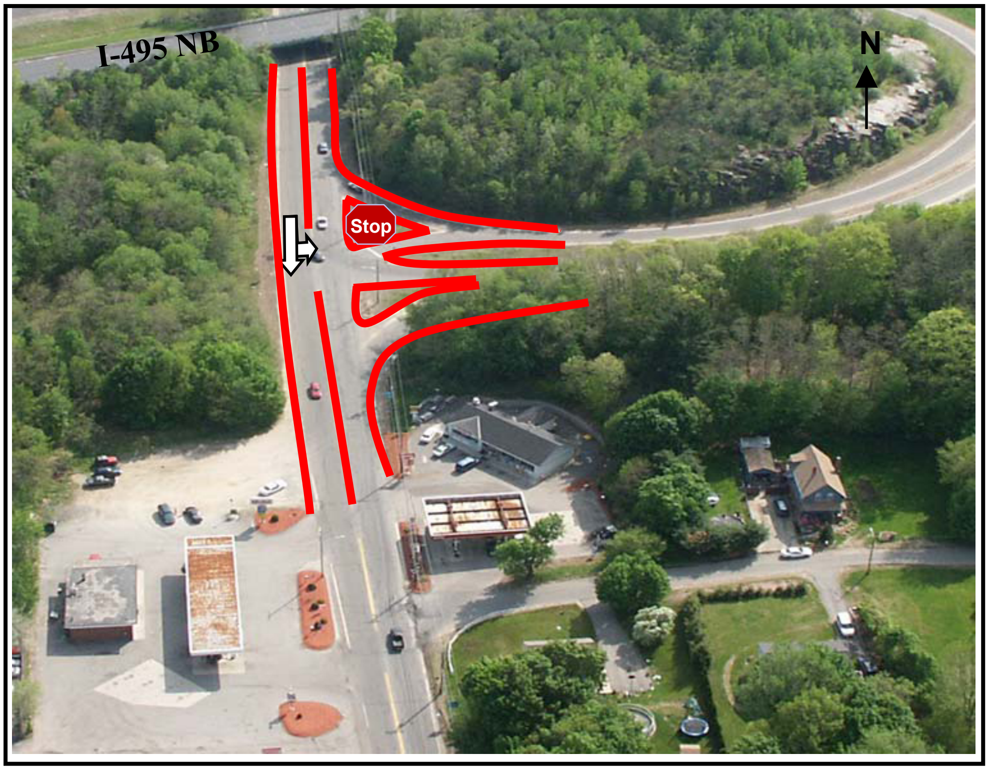
This intersection is illustrated on Figure 4-30 for existing conditions and with potential improvements.

4.6 Crashes

Table 2-5 in Chapter 2 indicated the ranking of the various interchanges in the I-495 study corridor according to total crashes, crashes with property damage, crashes with injuries, and crashes with fatalities.

There are no accepted methodologies available to predict the future number of crashes on a roadway, assuming no changes in the characteristics of the roadway. However, it can be anticipated that total crashes will increase in direct proportion to increases in traffic. Thus, if daily traffic volume increases 10 percent over 10 years, it is reasonable to expect that total crashes will increase by a similar percentage. Regarding the relationship between decreases in total crashes resulting from specific types of improvement projects, there are no accepted methodologies for predicting the number of crashes that will occur if improvements are made to the roadway. In addition, available crash data for I-495 and its intersections is, in many cases, not specific enough to isolate exactly where many individual crashes occurred or what caused them. Having said that, in locations where accepted design standards are not present or

Exit 52 NB at Route 110 in Haverhill (Existing)



Exit 52 NB at Route 110 in Haverhill (Proposed)

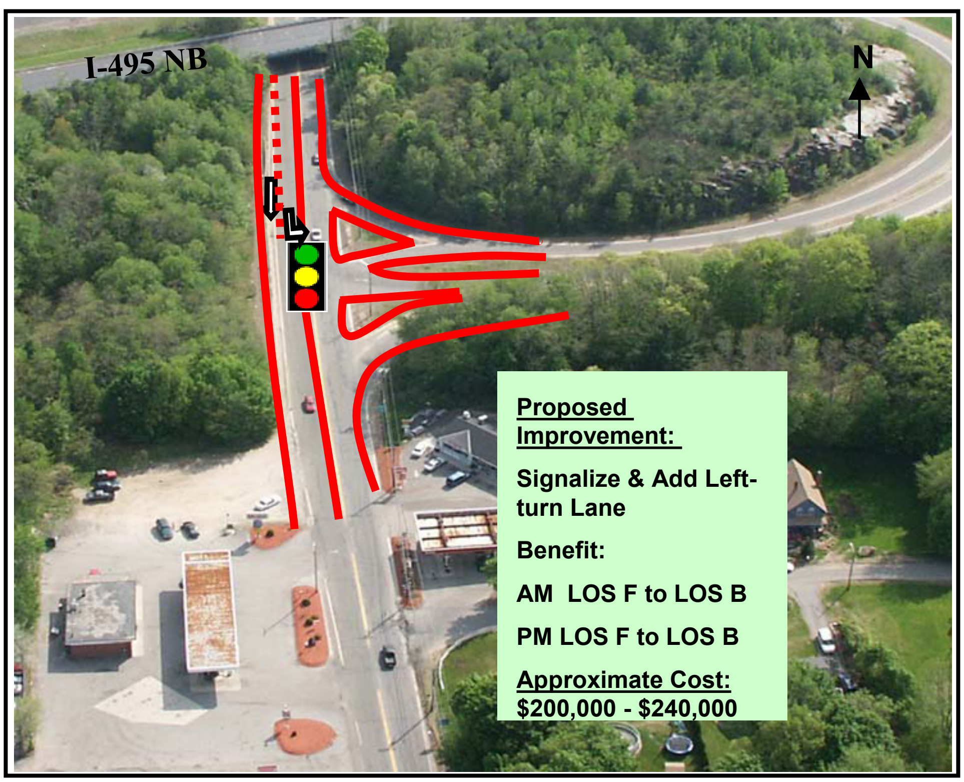


Figure 4-30
Existing Condition and Proposed Improvement at Exit 52 NB and Route 110 in Haverhill

crashes are occurring at uncontrolled high traffic volume intersections, a reasonable assumption can be made that attaining design standards or instituting control of traffic movements with a traffic signal could help to reduce the total number of crashes and/or their severity.

Consequently, with regard to the high-crash locations listed in Table 2-5, it can be said that this study has developed potential improvements of some type at all of the locations given in Table 2-5, with the exception of two locations. One of the two exceptions referenced above is Exit 35, the interchange of I-495 with U.S. Route 3. While the I-495 project is not proposing any specific improvements at this interchange, it is important to note that this area was recently upgraded as part of the recent U.S. Route 3 widening project. The crash data used in this study precedes the completion of that U.S. Route 3 work. Accordingly, it can be reasonably assumed that the completion of that project has now addressed at least some of the causes of crashes at this location. The other exception noted is at Exit 44 in Lawrence. This location is another intersection where traffic signals have been installed since the crash data was collected, as is Exit 32, Boston Road, in Chelmsford. It is anticipated that these improvement will result in a decrease in at least the severity of crashes at this location.

4.7 Intelligent Transportation Systems (ITS)

The purposes of intelligent transportation systems (ITS) are to provide information and to take actions that will allow the movement of people and goods to move more efficiently and safely through an area. For example, an overhead message sign may warn motorists of traffic congestion and/or a crash ahead, while a traffic signal system may change its timing in response to traffic conditions.

In the Northern Middlesex Council of Governments region, a Chapter on ITS is part of that region's Transportation Plan. It notes that a regional ITS architecture for Metropolitan Boston was completed in 2005. The services provided by SmarTraveler are summarized. The Plan then goes on to list other ITS technologies that may be suitable for future deployment in the region. Specifically mentioned is traffic monitoring on I-495.

Similarly, the Regional Transportation Plan of the Merrimack Valley Planning Commission (MVPC) also has a Chapter devoted to ITS. This Chapter also makes specific reference to the availability of SmarTraveler services in the Merrimack Valley, including real-time information on current traffic conditions on the region's major highways (I-495, I-93, and I-95). Also discussed are several possible signal coordination projects. With regard to the future, the plan notes the proposed widening of I-93

and the opportunities that it will allow for ITS technology to be incorporated into that roadway. The Plan also recommends that projects developed from the I-495 corridor study be integrated into the Boston Metropolitan Regional Architecture. It also foresees the use of ITS technology to warn of upcoming incidents on the region's major highways, including I-495, and for use at congested I-495 interchanges to relieve traffic back-ups (on ramps) from vehicles exiting the highway.

4.8 Potential New I-495 Interchange at State Route 225 in Westford

At the beginning of this study, NMCOG requested that the potential benefits of a new interchange with State Route 225 in Westford be evaluated. NMCOG's intended goal for a new State Route 225 interchange was to attract peak hour vehicle trips away from the congested Exit 32 (Boston Road interchange).

CTPS modified the study's traffic model to reflect a full directional interchange at State Route 225. The result of this evaluation was that, with a new State Route 225 interchange, AM and PM peak hour traffic volumes at Exit 32 (Boston Road) were only reduced by 50 to 80 vehicles in each peak hour. The larger benefit of a State Route 225 interchange was projected to occur at the State Route 119 interchange in Littleton. It should be noted that Exit 31 is outside this study's boundary. At Exit 31, peak hour traffic volumes decreased by several hundred vehicles. The results of this evaluation are contained in this study's Technical Appendix.

Additionally, by attracting traffic away from Exit 31 and to a new State Route 225 interchange, the intersection of State Route 225 with State Route 110 in Westford would be impacted due to 800 AM-peak-hour vehicles and the 600 PM-peak-hour vehicles traveling between I-495 and State Route 110 via State Route 225.

These findings were presented to NMCOG and the SAG in the spring of 2008. All agreed that an interchange at State Route 225 in Westford would not meaningfully improve peak hour conditions at Exit 32 (Boston Road) and would impact operations at the intersection of State Routes 110 and 225. Consequently, it was agreed to remove this action from further evaluation.

4.9 Summary of Improvement Costs

Table 4-1 presents a preliminary estimate of construction costs for the potential improvements described previously in this chapter. These estimates are based on current 2008 costs and do not reflect increases if the improvements are implemented in the future.

Table 4-1
Preliminary Estimate of Construction Costs

	Western Segment	Eastern Segment
Near Term		
Signal Timing Adjustments	$9,000	$3,000
Mid Term		
Accel/Decel Lanes	$20,000	$32,000
New Signalization	$1,350,000	$630,000
Reconstruct Route 125	N/A	$590,000
Long Term		
Exit 32 Ramp Reconstruction	$600,000	N/A
Add-A-Lane	$100,000,000	$71,000,000
Signal Timing Adjustments	N/A	$3,000
New Signalization	N/A	4,740,000
Total	**$101,979,000**	**$76,998,000**

The construction cost estimates developed for this planning study are purely conceptual, as no surveying, engineering, or design work has been conducted. As these improvements proceed into the next phase of project initiation and development, additional work may be necessary, such as minor lane or shoulder width widening, resurfacing, utilities, drainage, sidewalks, ADA accessibility, guardrails, conduits, pull-boxes, additional signs, and radii changes. Therefore, it can reasonably be expected that the current estimates of project costs may increase as the individual scopes of work are developed in more detail.

As can be seen from Table 4-1, the estimated construction cost for the improvements discussed in this Chapter for the Western Segment of the study corridor is $101,979,000, and for the Eastern Segment is $77,208,000. For the two segments combined, the total estimated construction cost is approximately $179 million.

It is important to recognize that the quoted construction costs, particularly those for the Add-A-Lane projects in the Western and Eastern Segments, will be substantially greater than given here by the time that the projects are actually implemented. The Add-A-Lane projects, as noted in the following text, will not be implemented until the long term, due to the 8-12 years required for their design and construction and to the fact that they are not currently needed in terms of providing an increase in mainline capacity. Construction costs in recent years have typically been increasing

at a rate far greater than that of inflation, with a 10 percent per year rise being typical. The long implementation time coupled with the rapidly rising rate of cost increases will together serve to guarantee that actual costs will be substantially greater than the costs based on 2008 dollars given in Table 4-1.

As a point of note, the Long-Term Add-A-Lane projects are the most complicated of all those being considered and would take the most time to implement. Specifically, it is estimated that it would take 5 to 8 years to bring them through the environmental impact assessment process and then to complete their design. Another 3 to 4 years would be required for construction, yielding a total implementation time of 8 to 12 years. Since these projects would have to be in place by 2030, work on them would have to start by 2018.

4.10 Next Steps

It is assumed that potential improvement projects identified in this Chapter for implementation in the near term, all of which are adjustments to existing traffic signal system timings, would be undertaken directly by MassHighway under its existing District Maintenance contracts.

For mid-term and long-term improvements, bringing these improvements to fruition would be undertaken within the framework of the so-called "3C" transportation planning process. The 3C process was developed several decades ago and involves "continuing, comprehensive, and cooperative" efforts among all levels of government—local, state, and federal—and also is dependent on public input throughout the process.

The first step involved in bringing a mid-term improvement project to ultimate implementation would be for the local community in which the particular project would be situated to support the concept of the project and then to become the project's advocate. The project would then be brought to the MassHighway District Office (District 4 in Arlington for all projects in the study corridor except for those in Westford, which would be handled by MassHighway's District 3 office in Worcester). After being added to the MassHighway database and being assigned an expeditor, the project is then brought to the regional planning agency for consideration and ultimately inclusion in the region's five-year Transportation Improvement Program (TIP). No federal funding for the project can be approved unless the project is on the TIP. Where the project is listed on the TIP (by future year) would be dependent upon the complexity of the project, time needed for engineering, available funding, etc.

Long-term projects are not initially put on the TIP since the TIP covers only a five-year period and, by definition, long-term project are eight or

more years into the future. Rather, the project proponent will request that the project be put on the region's long-range transportation plan. In the case of widening I-495 adding this to the long-range transportation plan would occur following coordination between the involved regional planning agencies and MassHighway. At some later time, the project could move from the long-range plan onto the TIP. Advancing projects of the magnitude of adding a lane to I-495 is typically the responsibility of MassHighway working through the previously mentioned 3C transportation process. By including participation by the two regional planning agencies NMCOG and MVPC and developing and involving the study-specific Study Advisory Group process, this study has begun the 3C process for all improvements presented in this chapter.

INTERSTATE

495